CIVIL ENGINEERING

Published by the American Society of Civil Engineers

CLEVELAND UNION TERMINAL BUILDINGS

Volume 1 AMERICAN SOCIETY OF CIVIL ENGINEERS FOUNDED 1852 *Number 2*

NOVEMBER 1930

Among Our Writers

WILBUR J. WATSON has practiced engineering and architecture in Cleveland for 40 years. He is the author of several works on bridge building.

H. D. JOUETT, who is considered an authority on railroad terminals, has recently been made Terminal Manager of the Cleveland Union Terminals Company.

CLAUDE P. MARSH served the New York Central Railroad in various engineering capacities for 20 years prior to his connection with the Cleveland Union Terminals Company.

WILLIAM E. PEASE has long been identified with the work of municipal improvement in Cleveland. One of his important positions was that of first Chief Engineer of the Cleveland Union Terminals Company.

JAMES A. STOCKER, after graduating from Ohio State University, entered the employ of the Ohio Central Railroads of the New York Central Lines, where he has been in continuous service for 28 years. He is now Chief Engineer.

C. S. ALBRIGHT and R. E. RICE are electrical engineers with the New York Central Railroad. Their experience with the Toledo Car Dumper plant is unique.

WENDELL P. BROWN, a graduate of the Sheffield Scientific School, has for eight years been president of a Cleveland firm of engineers bearing his name.

BURTON R. LEFFLER, is a bridge engineer with a long railroad career—first with the Burlington and the Lake Shore railroads, then with the New York Central.

WILLIAM E. STANLEY graduated with honors from Purdue and was later an instructor of civil engineering in the same institution. Since 1929 he has been associated with Pearse, Greeley, and Hansen, of Chicago.

CHARLES C. HOMMON'S experience as Assistant Sanitary Engineer of the Ohio State Department of Health, has been invaluable in his operation of the Canton, Ohio, Municipal Sewage Treatment Plant.

FRANK WOODBURY JONES is well known as a Sanitary Chemist, being now associated with George B. Gascoigne, Consulting Sanitary Engineer, of Cleveland.

DR. HERBERT F. KRIEGE, who has charge of tests at the France Stone Company Laboratories at Toledo, Ohio, can speak with authority on matters involving physical and chemical properties of materials of construction.

WILLIAM A. STINCHCOMB has to his credit many bridge, wharf, building, highway, and recreational projects in Cleveland.

ROLLAND S. WALLIS, formerly Research Engineer for the Regional Planning Federation of Philadelphia Tri-State District, brought to his work a long engineering teaching experience.

VOLUME 1 NUMBER 2

November 1930

AMERICAN SOCIETY OF CIVIL ENGINEERS FOUNDED 1852

Entered as second class matter September 23, 1930, at the Post Office at Easton, Pa., under the Act of August 24, 1912.

CIVIL ENGINEERING

Published Monthly by the

AMERICAN SOCIETY OF CIVIL ENGINEERS

(Founded November 5, 1852)

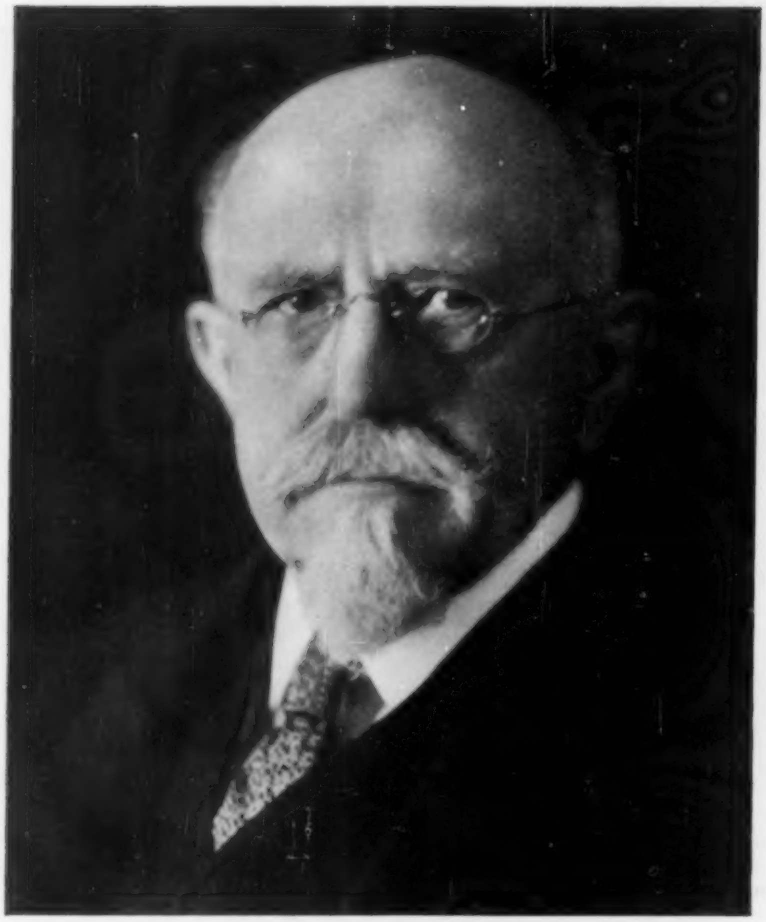
PUBLICATION OFFICE: 20TH AND NORTHAMPTON STREETS, EASTON, PA.

EDITORIAL AND ADVERTISING DEPARTMENTS:
33 WEST 39TH STREET, NEW YORK

This Issue Contains

SUBSCRIPTION RATES

Price, 50 cents a Copy; $5.00 a year in advance, in the United States; $5.75 a year in Canada; $6.50 a year in other Foreign Countries; $4.00 a year to Members and to Libraries; and $2.50 a year to Members of Student Chapters.



John Ripley Freeman

Engineer, scientist, and industrialist,
Authority on power, water supply, hydraulics, fire protection.
Consultant on vast engineering projects throughout the world,
Father of hydraulic laboratory practice in America,
Director of the Society 1896–1898, Vice-President 1902–1903, President 1922,
Elected Honorary Member September 29, 1930.

J. F. COLEMAN
President
GEORGE T. SEABURY
Secretary
SYDNEY WILMOT
Manager of Publications
WALTER E. JESSUP
Editor

CIVIL ENGINEERING

PUBLICATIONS COMMITTEE
HARRISON P. EDDY, *Chairman*
MORRIS KNOWLES
MALCOLM PIRNIE
OLE SINGSTAD
CHARLES H. STEVENS
W. L. GLENZING
Advertising Manager

VOLUME 1 — NOVEMBER 1930 — NUMBER 2

Erecting the World's Largest Roof

Airship Factory and Dock for Goodyear Zeppelin Corporation, Akron, Ohio

By WILBUR J. WATSON
MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
CONSULTING ARCHITECT AND ENGINEER, CLEVELAND, OHIO

THE Goodyear Zeppelin Corporation's factory and dock at Akron, completed in 1929, was designed and built to construct and house two super-Zeppelins for the United States Navy, each to contain 6,500,000 cu. ft. of helium gas. This enormous structure, as here graphically described by Dr. Watson, is large enough to house a 10,000,000-cu.-ft. ship; it would cover two recumbent Washington Monuments placed end to end; under its spacious roof an intercollegiate football game and a big league baseball game could proceed simultaneously. The comprehensive paper, which is here abstracted, was read before the joint meeting of the Construction and Structural Divisions of the Society at the Cleveland Convention, July 10, 1930.

IN THE latter part of the eighteenth century, the Montgolfiere brothers invented the hot-air balloon, and it was in one of their airships that Benjamin Franklin ascended in France and conceived the idea for his famous kite experiment. Count Ferdinand von Zeppelin began his notable work in 1900 at Friedrichshafen, Germany, when he started on his first 410-ft. rigid ship, containing only 400,000 cu. ft. of gas. Since then scores of larger ones have been completed, notably the Graf Zeppelin of 3,700,000 cu. ft. capacity. Thus the name Zeppelin has become synonymous, at least in the public mind, with lighter-than-air craft.

Two monster airships for the U. S. Navy, the ZRS-4 and the ZRS-5, the first of which is now under construction in the Goodyear Zeppelin Corporation's factory at Akron, Ohio, are to be 785 ft. in length with a diameter of 134 ft. and a capacity of 6,500,000 cu. ft. of helium gas. While the ZRS-4 is the largest airship so far undertaken, the dock has been planned to accommodate an airship as large as 10,000,000 cu. ft. in capacity. Because the principal purpose of this building, also designed and built by the Goodyear Zeppelin Corporation, is to serve as a factory for airship construction, it is thoroughly equipped with cranes, runways, and elevators. While essentially a factory building, it may be used in the future as a dock for ships in service, and this possibility has been borne in mind by the designers.

EARLY AIRSHIP STRUCTURE

Primarily, the non-rigid balloon is simply a bag of gas, usually hydrogen, carrying a wicker basket supported from the bag by a network of ropes. The semi-rigid airship has a structural keel which carries the cabin, the gas cells above being enclosed in an envelope which has no supporting framework. The rigid airship has a complete metallic framework of stiff construction, usually of duralumin. In the Zeppelin type this consists essentially of longitudinal girders connecting vertical rings, between which the separate gas cells are placed. A condensed comparison of airships of the Zeppelin type is given in Table I.

The shape of the hangar was determined only after a careful consideration of wind conditions, since a building that serves as a shelter for lighter-than-air craft must cause the least practicable interference with normal wind currents. In mathematical terms, it may be described as being two semi-paraboloids connected by a parabolic cylinder. That is, sections taken across it form parabolas, and its longitudinal section forms two half parabolas connected by a straight line. This shape has been described as a half egg, but a better simile would be a half of a silkworm's cocoon, cut in two the long way.

Between center lines of door tracks, its length is 1,175 ft.; its width is 325 ft. from center to center of the arch pins; and its height, $197^1/_2$ ft. from center of lower to center of top pins. The height from the floor to the platform at the top is 211 ft. The floor area is 364,000 sq. ft., nearly $8^1/_2$ acres, much the largest single, uninterrupted floor area yet built.

TABLE I. FIVE AIRSHIPS COMPARED

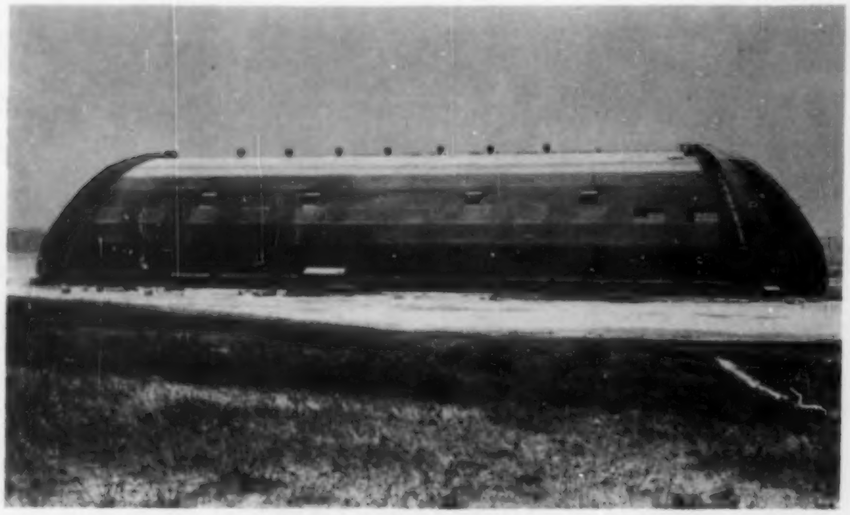
NAME OR DESIGNATION	LOS ANGELES	GRAF ZEPPELIN	ZRS-4 ZRS-5	R-100
Nominal gas volume, in cubic feet	2,470,000	3,710,000	6,500,000	5,000,000
Length over-all, in feet	658.3	770	785	709
Maximum diameter, in feet	90.7	100	134	133
Height over-all, in feet	104.4	113	147	...
Gross lift, in pounds	153,000	258,000	403,000	...
Useful lift, in pounds	60,000	...	193,000	...
Number of engines	5	5	8	6
Total horsepower	2,000	2,650	4,800	4,200
Maximum speed, in miles per hour	73	80	84	81
Range without refueling at 50 knots cruising speed, in nautical miles	3,500	5,300	10,000	4,000 (at 75 m. per hr.)

In its final design, the building conforms to the three major requirements formulated as a result of exhaustive studies by Dr. Karl Arnstein:

1. The cross section interrupts the stream flow of the air as little as practicable.

2. Strength is provided for local pressure differences directed inward in the upper region in addition to local pressure differences directed outward in the lower (windward) region.

3. Automatic pressure-relieving vents are provided to equalize exterior and interior pressures.



THE GOODYEAR ZEPPELIN CORPORATION'S COMPLETED AIRSHIP FACTORY AND DOCK AT AKRON

Experiments with hangar models made by A. G. Eiffel in France, in 1914, were the first to show that a current of air impinging upon an obstacle causes positive pressure in front and suction at the sides and rear. These experiments and later studies made by Professor Gruening in Germany indicated that the outward force should be assumed as greater than one-half the inward, with provision for securing the roofing against local outward forces equal to the full direct pressure. American practice in designing buildings to resist wind pressure has heretofore neglected the importance of these suction, or outward, pressures. From experimental data, obtained by observation of the effect of wind current on a model, the curve of pressures shown in Fig. 1 was constructed and followed by the designers of the structure.

It was the consideration of air currents that led to the adoption of a quadrispherical, or "orange-peel," type of door at the Akron Airship Dock. Open doors of the sliding type have been observed to create secondary air currents with twice the pressure of the prevailing winds.

OTHER LARGE DOCKS STUDIED

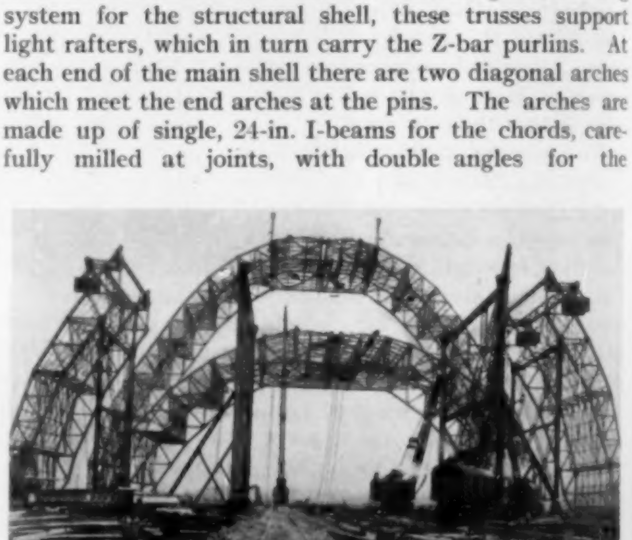
An important part of the preliminary studies was a comparison with some other docks previously constructed. The original Zeppelin shed at Friedrichshafen, built in 1908–1909, is $603^1/_2$ ft. long, 150.8 ft. wide, and 65.6 ft. high. Later a larger hangar was built, having a length of 787.2 ft., a width of 150.8 ft., and a height of 114.8 ft. These hangars, and most others built in Europe, are of structural steel arches, with sliding doors at the ends. The Luftshiffbau Zeppelin Corporation has recently completed a new hangar at Friedrichshafen equipped with cylindrical doors instead of straight sliding doors.

At Orly, France, two reinforced concrete hangars have been built, having a length of 984 ft., a span of 298 ft., and a height of 194 ft. 6 in. These hangars have not yet been equipped with doors. The cross section is parabolic, similar to the Akron building, and the structure is made up of reinforced concrete ribs connected with reinforced concrete curtains between the rings.

So far, the largest hangar built by the British Government is that at Karachi, India, for the proposed England-India service, which has a length of 850 ft., a span of 230 ft., and a clear height of 170 ft. The largest hangars constructed in the United States are those at Lakehurst, N.J., and at Belleville, Ill. The former has a length of 803 ft., a span of 264 ft., and a height of 172 ft., to the upper pin, and is intended to house two large ships. The latter has a length of 810 ft., a span of 150 ft., and a height of 150 ft.

All of these hangars have vertical doors that open horizontally, from the center outward. The orange-peel, or quadrispherical door, a distinctive feature of the Akron dock, never had been used except on a few much smaller buildings in Germany.

Essentially, the Akron dock may be described as consisting of 11 parabolic arches placed 80 ft. from center to center and connected by a unique system of vertical and horizontal trusses. In addition to forming the bracing system for the structural shell, these trusses support light rafters, which in turn carry the Z-bar purlins. At each end of the main shell there are two diagonal arches which meet the end arches at the pins. The arches are made up of single, 24-in. I-beams for the chords, carefully milled at joints, with double angles for the



ERECTING MAIN ARCHES
Center Section being Lifted into Position

web members. The maximum chord stress to be provided for is 978,000 lb. All vertical and horizontal trussed purlins are simple Pratt trusses built up of angles placed back to back, and the rafters are triangular trusses with the ends framed into the upper chord of the vertical trusses and the outstanding chord of the hori-

zontal trusses. The framing for the doors is made up of five semi-arches and bracing similar in every respect to that for the main shell.

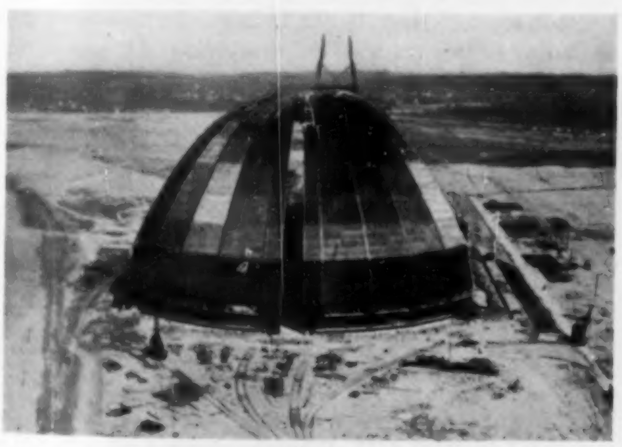
UNIT STRESSES FOR TREMENDOUS LOADS

In designing the structure, the following loads were used: a live load of 4 scaffolds of 6 tons each, suspended on 4 cableways and carried by 2 longitudinal beams; ship-suspension loads at 10 tons each, spaced 45 ft. longitudinally along the center of the building; a load of 50 lb. per sq. ft. on the top gangway; and loads of 6 tons per trolley on hoisting beams.

Dead loads were assumed at 10 lb. per sq. ft. on sheets, purlins, and rafters; 20 lb. per sq. ft. on laterals; and 30 lb. per sq. ft. on arches. On all surfaces inclined less than 45 deg. to the horizontal, snow loads were assumed at 30 lb. per sq. ft., when in combination with dead load only; and at 15 lb. per sq. ft. in combination with maximum wind load.

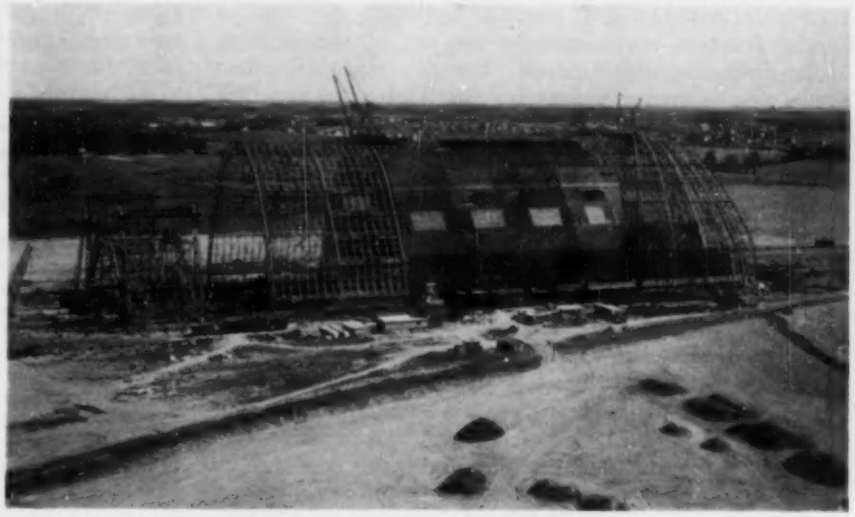
Wind pressures were taken at 80 lb. per sq. ft. on all sheets, purlins, and rafters for the upper part of the building, and at 40 lb. for the lower part; at $37^1/_2$ lb. per sq. ft. on all bracing and arches, combined with internal forces of $12^1/_2$ lb., as shown in Fig. 1; and a direct horizontal wind pressure of 15 lb. per sq. ft. on the external surface only, with no consideration of interior forces.

For the design, working stresses were adopted, for dead and snow load only, of 18,000 lb. per sq. in. on structural grade steel, and of 24,000 lb. per sq. in. on silicon steel. In the case of maximum stresses due to wind load, 24,000 lb. per sq. in. was assumed on structural grade steel, and 32,000 lb. per sq. in. on silicon steel.



ORANGE-PEEL, OR QUADRISPHERICAL DOORS

After careful estimates of comparative costs were made for designs, using, first, carbon steel, and, second, silicon steel, and assuming the silicon steel to cost $20.00 per ton more than the carbon, the arches were constructed of silicon steel with an ultimate strength of 80,000 to 95,000 lb. per sq. in., and a minimum yield point of 45,000 lb. per sq. in. However, no economy in size could be obtained in the rafters and bracing by using silicon steel, due to the fact that minimum sections were generally required, so these members were built of carbon steel with an ultimate strength of from 55,000 to 65,000 lb. per sq. in., and a minimum yield point of 30,000 lb. per sq. in.



SEQUENCE OF ERECTION OPERATIONS

ARCH STRESSES CAREFULLY ANALYZED

In determining the section of members in the main supporting arches the following assumptions were made:

1. The snow load may apply to all or to either half of the roof area, giving three possible sets of snow-load stresses.

2. The wind load of 15 lb. per sq. ft. of vertical surface was reduced to normal roof load by Duchemin's Formula and gave two sets of wind-load stresses.

3. The wind-pressure diagram shown in Fig. 1 was used to determine maximum stresses in all members except a few which received their maximum stresses in combination with load (2). These loads give four additional sets of wind-load stresses.

After including dead load, the above conditions produced ten stresses for each arch member. These were combined as follows:

Case I. Dead load and the maximum of snow-load stresses (1).

Case II. Dead load, one-half of maximum of snow-load stresses, and maximum of wind loads (2).

Case III. Dead load, one-half of maximum of snow-load stresses, and two maxima of the two wind loads (3).

It was decided that the main arches should act under dead load as three-hinged and as two-hinged under all other loads. This made necessary the analysis of the statically indeterminate two-hinged arches. In order to determine approximate cross section of members, a trial solution was first made determining all stresses for a three-hinged arch. All stresses were determined graphically, placing the diagrams on Van Dyke prints having the truss outline, reaction influence lines, and tables for stress tabulation on the original. Owing to the large

number of members in the arches, this saved considerable time and labor of a routine nature. In constructing the stress diagrams, templates having the slope of each inclined member laid out to a large scale were used, adding much to the accuracy as well as to the speed of the work.

These stresses were then combined and trial cross sections of members were determined, giving due consideration to the probable changes in stresses due to the two-hinged arch action. These trial sections having been determined, a unit horizontal thrust was applied at the reaction hinge, and by the use of the Williot-Mohr diagrams and Maxwell's law of reciprocal deflections, new influence values for the horizontal reaction were found. Correct values of the stresses were then determined for all loads. These were combined, giving new sections. New influence values for the horizontal thrust based on these new sections indicated that a third determination of stresses would be unnecessary.

The diagonal arches at each end of the building were considered as three-hinged under all conditions of loading and therefore required no special attention. Likewise, the trusses on arches supporting the door covering were designed assuming the reaction at the top pin to be horizontal, all vertical load being carried by a hinged reaction at the base. No variations from standard practice were made in designing the bracing and purlins although several assumptions were investigated as to the distribution of resistance to the longitudinal thrust at the door rib pins at each end of the building.

DEFLECTION DETERMINATIONS IMPORTANT

In order to provide suitable details at the top pin for door ribs, the proper closing details between doors and building, and to consider mutual effects of end and diagonal arches, it was essential that a careful study of deflections be made. Williot-Mohr diagrams were used in determining all deflections, and only sufficient algebraic work for checking these diagrams was carried out.

Differential deflections between end arches, diagonal arches, and door rib arches were computed for the top pin, and details designed accordingly. Differential movements between all panel points on diagonal arches and door rib arches were studied and provided for in designing the closing strips and the members themselves.

UNIQUE DOORS DESIGNED

Each leaf of the end doors weighs about 600 tons, not considering the snow that may accumulate or the wind pressure against it. To provide for the opening of these doors, each leaf is supported by 40 forged-steel, double-flanged wheels, 27 in. in diameter, running on a standard-gage railroad track with the 100-lb. rails curved to a radius of 187.69 ft. A curved runway of reinforced concrete constructed over a series of concrete piles driven to solid rock supports the track.

A very important unit in this design is the hinge pin that fastens the top part of the doors to the main shell of the building. These hinge pins are secured to the roof girders by heavy steel frames.

A pin 17 in. in diameter and 6 ft. long is required to resist the side pressure against it caused by the door tending to fall inward. However, because the door is horizontal at the top, where it bears against the pin, the pin does not need to carry any vertical weight whatever, except when a strong wind blowing through the building (when the doors on the other end are open) is of sufficient strength to tip it backward, at which time it is required to hold the door from being blown out. It is estimated that the pressure against the pin may reach a maximum of about 550,000 lb. inward, or 450,000 lb. outward, depending on snow and winds.

What is termed a "rack drive" system operates the doors. It consists of a very large gear called a "bull gear," with heavy, coarse teeth, mounted horizontally on a fixed concrete base just outside of the dock (one at each corner of the building), set far enough to the side to be in the clear of the open yard in front. This is revolved by a train of gears connected to a 125-hp. motor, through a worm-gear reduction. The worm-gear reduction is selected because of its characteristic of being self locking so that as soon as the power of the motor is shut off, the gear stops and cannot be started again in either direction by pressure of wind tending to back off the gearing. The rack is rigidly attached to the base of the door leaf. The doors may be opened or closed in five minutes.

EXPANSION AND CONTRACTION PROVIDED FOR

The fact that there were absolutely no expansion joints provided in this great structure makes this a subject of especial interest. The three center arches are fixed in position, while all others are carried upon rollers, placed transversely to the axis of the structure, allowing it to expand freely as a whole, from the center to each end. This allows the end arches, supporting the upper door pintles or hinges, to move laterally about 4 in. under the maximum range of temperature, a motion which is taken up partly on the pins themselves and partly transmitted to the doors and absorbed by the door frames in bending.

Forces exerted by the expansion and contraction of the steel are transmitted to the shoes by diagonal struts from a continuous strut placed above the doors. These struts constitute the only redundant members in the entire structural scheme, and after the completion of the erection some of them began to buckle. This was found to be due to two causes: the shortening of the main ribs under load, and the introduction of an element of friction between the siding and the concrete curb of the floor. The curb was cut down to give entire freedom of movement and some of the diagonals reinforced, as the engineers thought that unforseen friction of this kind might, in the future, be caused by ice, snow, and dirt.

It should be borne in mind that the main arch shoes are horizontal, and subjected to horizontal forces as well as vertical. The horizontal forces are transmitted to the footings through flat plates on the upper and lower shoe plates that engage deep slots in the rollers. The vertical reaction on each typical arch shoe due to dead load only is 677,000 lb., and the horizontal reaction is 200,000, a ratio of 1 to 3.38. The horizontal reaction may, under certain conditions of wind load, be reserved and amount to 119,000 lb. inward instead of outward.

An interesting detail in connection with the expansion and contraction of the structure is the arrangement of the pins supporting the doors. These are 8 in. longer than the bearing of the castings surrounding them, allowing the top of the door to slide up and down on the hinges.

in order to take up part of the movement of the pin in this way. Observations made thus far indicate a range of movement of about 2 in.

As computed, the rise and fall of the upper arch pins under wind may be 1.68 in., while their horizontal movement may be as great as 9.47 in. The maximum vertical movement of the arch ribs—this does not occur at the pin, however—is 5.46 in., and clearances between the main shell of the building and the doors had to be very carefully computed for all conditions of loading in order to make certain that there would be no interference.

ROOF COVERING

For the material of the roof, the major requirement was that it should be fire resistant, comparatively light in weight, and of such a nature that it would not rupture under the strains caused by the slight motion of the structure due to high wind velocities. Material used was a deep, angular, corrugated sheet metal classified into types depending on its location on the building, that is, whether on a vertical, steep, or flat portion of the roof.

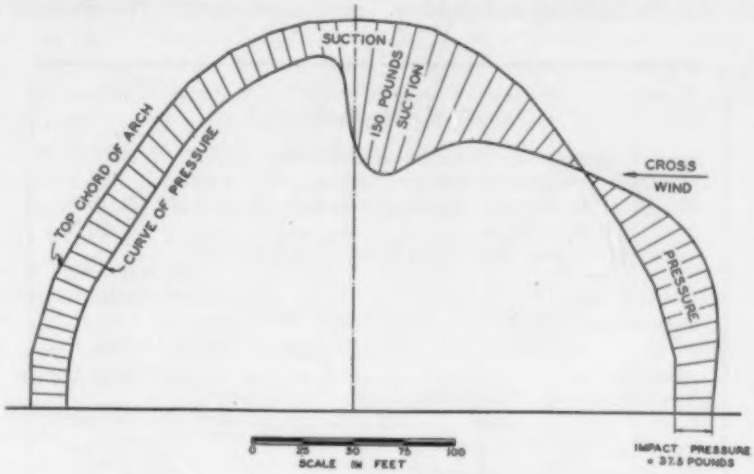


Fig. 1. Curve of Wind Pressures Used
Results of Dr. Karl Arnstein's Guggenheim Wind-Tunnel Experiments

Type A consists of a 22-gage core metal hermetically enclosed in an asphaltic protective covering, and was designed to withstand an ultimate load of 100 lb. per sq. ft. from either side, with a limiting deflection of 2 per cent of the span. Type B, 20-gage metal, was designed for an ultimate load of 200 lb. per sq. ft. from either side. In order to overcome condensation, this roof was covered with an inch of insulating material and then waterproofed with a standard "steep surface" roof covering guaranteed for ten years. In general, Type C was the same as Type B except that waterproofing material was to be of standard, flat-surface roof covering.

UNUSUAL CONSTRUCTION AND ERECTION PROBLEMS MET

The substructure work included; concrete footings for the arches, carried on vertical and inclined concrete piles driven to rock; concrete ties across the building, laid on the sand and clay after removing the muck, and heavily reinforced to take the thrust from the arches; concrete door foundations for supporting the rails carrying the doors, which are also carried on concrete piles; a concrete service tunnel the full length, and one-half the width of the building; and two lines of concrete docking rail supports. The piles are of the MacArthur type, carrying maximum loads of 30 tons each.

The typical arch foundations are subjected to dead-load reactions of 340 tons vertical, and 100 tons horizontal, while the maximum reactions under the worst possible combinations of dead, snow, and wind loads are 472 tons vertical and 168 tons horizontal. These reactions are taken by reinforced concrete footings 15 ft. square and 5 ft. 6 in. deep, each of which is carried by 25 piles of which 10 are battered, about 4 in. to the foot. These battered piles are along the inside and outside lines. The footings are tied together by reinforced concrete ties carried entirely across the building, underneath the floor. These ties are 2 ft. 3 in. deep by 4 ft. 0 in. wide, and are reinforced with 12 bars $1^1/_4$ in. square.

Tracks for supporting the spherical doors are 10 ft. wide by 5 ft. 6 in. deep, reinforced with 22 bars $1^1/_4$ in. square and supported on two rows of concrete piles 7 ft. apart and 9 ft. center to center of piles. The segmental door foundations are tied into the center tunnel and into the docking rail supports at all intersections.

In erecting the superstructure, the lower section of a pair of arches about 100 ft. high and 80 ft. apart were first erected upon temporary bents, as shown in the illustration. All the bracing between the two arches was placed to this height. Then the center portions of the arch sections were assembled on the ground and lifted into position by means of counterweights attached to a four-part steel-cable hoisting rigging fastened to the tops of the side sections already erected.

Erection started with the two southerly arches of the three fixed center arches, and proceeded southward to the south doors, which were erected in open position, supported upon the exterior of the main structure, and assembled by locomotive cranes as high as these could reach and above this point by a derrick traveler on top of the arches.

The erection bents for supporting the side sections of the arches consisted of two steel columns, each supported upon a 300-ton jack at its base, the function of the jack being to spread the tops of the lower sections enough to allow the center section to pass by and then to bring them together again in order to effect the closure between the two sections.

At the top of these columns were placed the sheaves for carrying the counterweight boxes weighing about 72 tons, each pair loaded and equivalent to about 80 per cent of the weight of the center portion of the span, leaving about 20 per cent to be lifted by the cranes. Each center section erected weighed about 360 tons. The center sections were assembled by the cranes upon cradles which comprised longitudinal girders carrying the ends of the arches and transverse ties to take up the thrust.

The erection plan involved the use of eight lines of railroad tracks, two outside the building, and six inside. Altogether, about $1^1/_2$ miles of standard gage railroad tracks were used at one time, on which operated seven locomotive cranes, five having 50-ft. booms, and two

having 105-ft. booms with goose-necks which gave them a total reach of about 125 ft.

FIRE PROTECTION

As no precedent had ever before been presented to the fire underwriters, new rulings were required for this building. The underwriters requested that only incombustible materials be used in the construction, which eliminated wood roofing.

It was also requested that a system of outside and inside fire hydrants be installed and connected to an automatic fire pump located outside the building and capable of boosting the normal pressure of 50 to 60 lb. per sq. in. to 125 lb. per sq. in. Water is brought to the pump house just east of the building by a 12-in. main, and from that point a 10-in. loop is carried entirely around the building. This 10-in. loop supplies 12 outside fire hydrants, and 24 inside hydrants. In addition to these water lines, chemical fire extinguishers are distributed liberally throughout, on the main floor, on catwalks, and on the upper platform.

SUMMARY OF STATISTICS

Length, from center to center of end doors		1,175 ft.
Width, from center to center of hinges		325 ft.
Height, from center to center of hinges		197 ft. 6 in.
Perimeter of arch		562 ft.
Interior floor area, from center to center of door tracks		364,000 sq. ft.
Cubical contents		55,000,000 cu. ft.
Area of roof: Shell	514,900 sq. ft.	
Doors	178,100 sq. ft.	693,000 sq. ft.
Skylights		23,000 sq. ft.
Reinforced steel: Reinforcing bars	540 tons	
Rails	160 tons	700 tons
Structural steel in doors		1,900 tons
Structural steel in shell and shops		5,500 tons
Total weight of steel		7,400 tons
Approximate weight of roof covering		1,200 tons
Total weight of completed structure		8,800 tons
Concrete foundations, and floors		15,200 cu. yd.
Number of piles (all about 25 ft. long)		1,300
Weight of one door leaf		609 tons
Construction period		14 months
Earth handled in preparation of 60-acre site		1,000,000 cu. yd.

HELIUM STORAGE

For the airships now being built at this plant only helium gas will be used. The gas used in all countries except the United States is the inflammable hydrogen, but helium is largely used in the United States. Helium is an inert, non-explosive and non-burnable gas, possessing only about 83 per cent the buoyancy of hydrogen, but much more safe. It is found in combination with nitrogen at several places in the western states. Its lifting capacity is 0.0656 lb. per cu. ft., assuming the gas to be 94 per cent pure, 60 deg. air humidity, 29.95 in. barometric pressure, and 32 deg. fahr. air temperature.

Helium is shipped from the field in small steel "bottles" about 4 ft. long and 9 in. in diameter and about 1.28 cu. ft. in capacity. Into this space is compressed about 170 cu. ft. of free gas under a pressure of about 2,000 lb. per sq. in. To supply gas by this method for the ship now being built will require 38,000 such bottles. The United States Navy has built some special tank cars with a capacity of 600,000 cu. ft. of gas, and it is expected that most of the helium used at the Akron plant will be delivered in this way.

Gas will be taken directly from the tank cars or bottles into the gas cells of the ship or into the storage cylinders, as desired. The gas will be drawn out of the cells by the suction pump, which will be able to deflate 1,000,000 cu. ft. in 24 hr. and place it into storage at a 750-lb. pressure, or which may, at a slower rate, compress the gas back into the cylinders or tank cars at a 2,000-lb. pressure for reshipment. The purifying plant is necessary in order to remove air and other impurities which mix with the helium and decrease its lifting power.

These storage tanks, 96 in number, are built for a working pressure of 750 lb. per sq. in. and were tested with a pressure of 1,250 lb. per sq. in. at the shop, corresponding to a unit tensile stress of 28,000 lb. per sq. in.

They are 24 in. in outside diameter; 80 ft. $2^{1}/_{4}$ in. long over all, with a shell thickness of $^{1}/_{2}$ in.; and have flat heads $2^{1}/_{4}$ in. thick, joined to the shell with one girth seam each. The material is open-hearth steel with a minimum ultimate strength of 60,000 lb. and a yield point of 38,000 lb.

Before use, a high pressure test is made, intended to produce a stress equal to 75 per cent of the yield point of the material, in addition to which the vessels are subjected to a hammer test developing a stress of 60 per cent of the yield point. The high-pressure test is equal to

$$\text{Pressure} = \frac{\text{twice thickness} \times \text{unit stress}}{\text{internal diameter}} = \frac{2 \times {}^{1}/_{2} \times 28{,}000}{23}$$

which equals 1,220 lb. per sq. in., or 1.62 times the working pressure. The pipes are "pickled" and one coat of coal-tar primer is applied at the shop. In addition, two coats are applied in the field.

These tanks are placed underground, in two layers, supported on three lines of concrete footings, and are covered with 12 in. of gravel. They are in two groups, with a concrete valve pit between. The tanks are valved in groups of five, and connected with 4-in. pipes. The main pipes to the compressor are 6 in. in diameter, as are also the deflation pipes inside the building. The 4-in. inflation outlets are located in the center tunnel.

Before adopting this method of storing helium gas, careful estimates of cost were made, comparing this method with storage in gas holders at atmospheric pressure or in large forged high-pressure cylinders and storing at the intermediate pressure, was the most economical.

ACKNOWLEDGMENTS

Mr. P. W. Litchfield is President of the Goodyear Zeppelin Corporation; Dr. Karl Arnstein, Director of Engineering; W. C. State, Consulting Engineer; and the firm of Wilbur Watson & Associates handled the engineering and architectural features. The general foundation contract was awarded to the MacArthur Concrete Pile Corporation, and the structural steel was furnished and erected by the American Bridge Company.

Cleveland Railroads Dedicate Union Terminal

An Electrified, Ultra-Modern Passenger Project Completed

By H. D. Jouett

Chief Engineer, Cleveland Union Terminals Company

An impressive group of thoroughly modern metropolitan buildings, dominated by a 52-story tower, forms the most visible evidence of the existence of a Union Station in Cleveland—a group that does not conform to any of our older conceptions of the proper appearance for a great passenger station. One immediately concludes that precedent was not permitted to influence the plan. It provides for the commercial utilization, in the air-right buildings, of every cubic foot of space over the trackage not actually needed for transportation. Mr. Jouett, who brought to Cleveland a previous experience as Terminal Engineer of the Grand Central Station in New York, here describes the bold plan developed by him and his associates. His paper was presented before the Society on July 9, 1930, at its Cleveland Convention.

Cleveland's Union Terminal project received its first public notice when, in 1918, A. H. Smith, then Federal Regional Director of Railroads, gathered about him a group of engineers to investigate a proposed plan for a passenger station fronting on the Public Square. After a favorable decision had been reached by this pioneer group, the plan was submitted to the city, was accepted by an ordinance enactment in 1918, and was ratified by popular referendum on January 6, 1919. In the fall of 1920, a contract was negotiated by the New York Central, the Nickel Plate, and the Big Four on the one hand, and the Cleveland Union Terminals Company, a Van Sweringen incorporation, on the other, for the construction and use of the station. The Interstate Commerce Commission approved the project a year later, in 1921. Immediately thereafter, early in 1922, the engineering forces were organized and construction was commenced.

Although participation had been confined to the three railroads named, there is no thought of departing from the original plan of a union passenger station to serve all the railroads entering Cleveland, in addition to the rapid-transit trains of the Cleveland Traction Terminals Company, which is now using the new terminal facilities under agreement. Contract for use of the station has been made with the Wheeling & Lake Erie, whose station had to be removed to make way for the present terminal. The other railroads which will no doubt ultimately make use of the Union Terminal facilities are the Erie, the Baltimore and Ohio, and the Pennsylvania.

Topography Had to Be Adapted

To appreciate the scope of the project and the construction difficulties that had to be overcome in the execution of the plan, it will be advantageous to describe the topography of Cleveland and its immediate surroundings. The business section of the city occupies a comparatively level area lying 90 ft. or so above the level of Lake Erie—an area which drops abruptly to the shores of the lake and through which the Cuyahoga River has cut a tortuous course, entering Lake Erie a half mile west of the Public Square.

When the railroads were originally constructed, they entered the city along the low, level valley of the Cuyahoga River and its tributaries, and along the narrow shore of the lake, each road locating its terminal facilities along its own line of approach. The old Union Terminal on the lake front, at the foot of West Ninth Street, was built and used by the New York Central, the Big Four, and the Pennsylvania. Each of the other lines had passenger stations as well as freight terminals either along or near the Cuyahoga Valley.

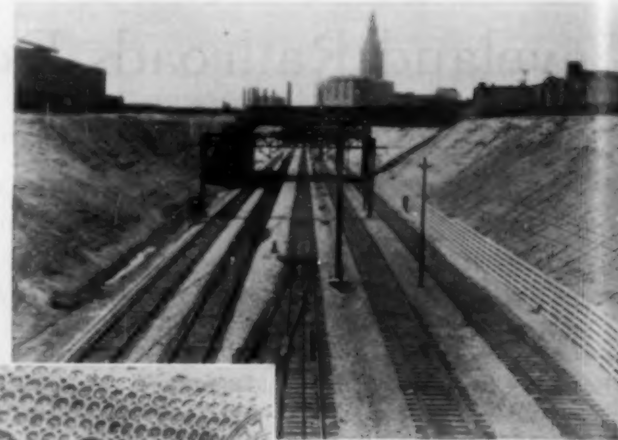
The Public Square lying between the Cuyahoga River and the lake has been the center of business and commercial activity toward which the main highways of the district converge. The growth of business has gradually moved the center of activity eastward along Euclid Avenue with a large increase in property values in the immediate vicinity resulting. But, on the other hand, an area occupied by obsolete buildings, lying in the triangle between Ontario Street, Superior Avenue, and Canal Road, had actually depreciated in value in spite of the fact that one corner fronts on the Square—an area which was not able to overcome the handicap of its sharp slope toward the river flats on the south and its resulting lack of through streets.

A New Street Plan Developed

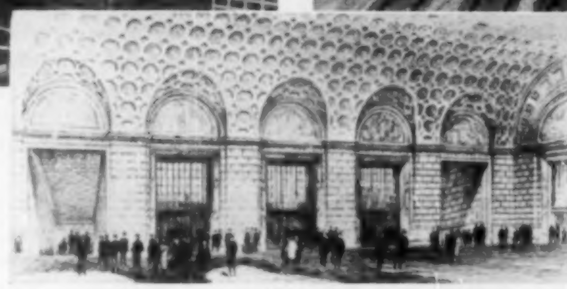
This was the area selected for the terminal, the first step in the development of which consisted in projecting both Prospect Avenue and Huron Road westerly across it from Ontario Street to intersect with Superior Avenue, and raising them on viaducts substantially level with both Ontario Street and Superior Avenue. In spite of the comparatively low value of the site selected for the station, a large amount of improved property was incorporated within the area needed for rights of way, and whole blocks of business, industrial and residence buildings were acquired and razed to make room for the approach tracks and the terminal itself.

Since the heaviest carrier of passenger traffic, the New York Central, is a through line, and Cleveland is a way station for most of the passenger-carrying lines, it was necessary to design a station of the through type. The plan was so developed that railroads other than the three principals could be accommodated in it. One approach was constructed across the north end of Cuyahoga Valley on a high viaduct, continuing through a cut

THE UNION TERMINAL BUILDING FROM THE PUBLIC SQUARE



EAST APPROACH CUT LOOKING TOWARD THE TOWER



THE BEAUTIFUL ENTRANCE PORTICO

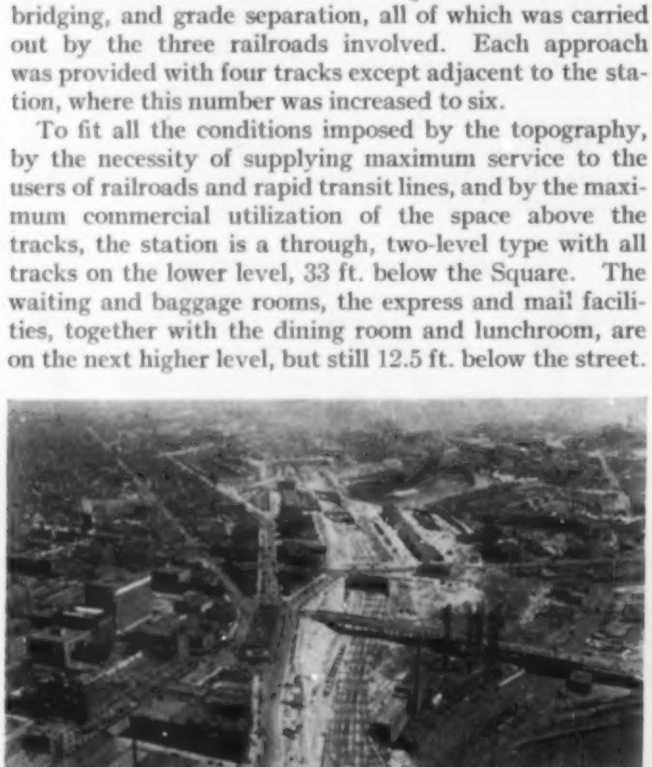
in the high ground on the western side of the valley to West 25th Street, just east of the point of intersection of the Big Four and the Nickel Plate with Walworth Avenue; the other followed, in general, the east side of the valley to connect with the Nickel Plate Lines at East 37th Street.

Between these limits, a strip 4 miles in length, comprising the terminal, with the station in the approximate center, is owned by the Union Terminals Company, which constructed the improvements on it. The developments along the approach routes outside these limits involved a maze of new trackage, its electrification, bridging, and grade separation, all of which was carried out by the three railroads involved. Each approach was provided with four tracks except adjacent to the station, where this number was increased to six.

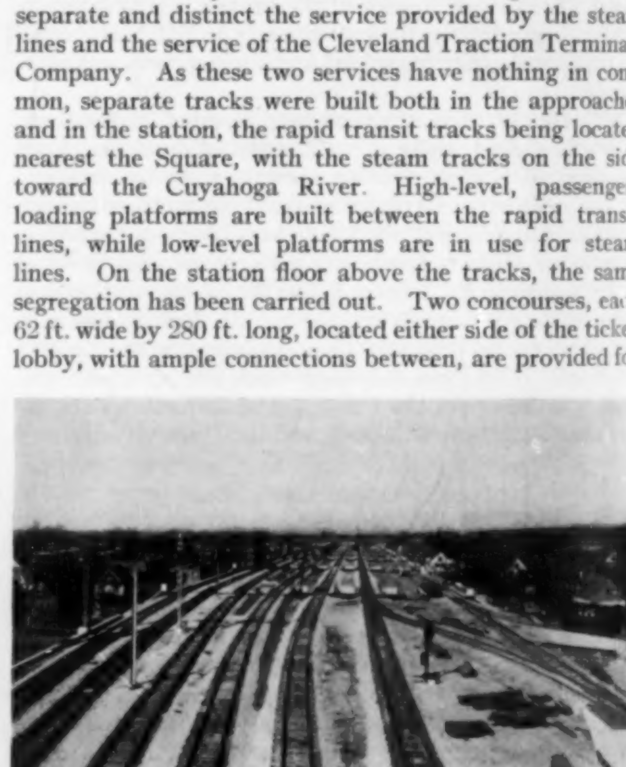
To fit all the conditions imposed by the topography, by the necessity of supplying maximum service to the users of railroads and rapid transit lines, and by the maximum commercial utilization of the space above the tracks, the station is a through, two-level type with all tracks on the lower level, 33 ft. below the Square. The waiting and baggage rooms, the express and mail facilities, together with the dining room and lunchroom, are on the next higher level, but still 12.5 ft. below the street. Huron Road and Prospect Avenue are constructed over the concourse 27.5 ft. higher than its floor level, thereby providing ample headroom for ceilings. The only part of the station projecting above the street level is the arched roof of the concourse.

FACILITIES PROVIDED FOR RAPID TRANSIT LINES

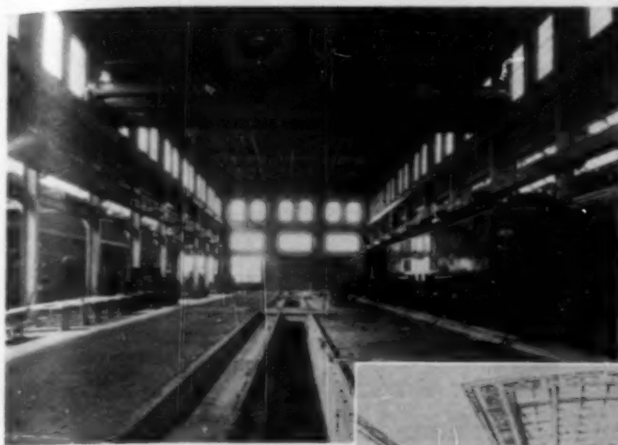
The ultimate track capacity of the station area is 10 for rapid transit and 24 for steam railroads. In the present initial development, 6 are provided for rapid transit and 12 for steam lines. The others are being used for a coach yard. The station is designed to keep separate and distinct the service provided by the steam lines and the service of the Cleveland Traction Terminals Company. As these two services have nothing in common, separate tracks were built both in the approaches and in the station, the rapid transit tracks being located nearest the Square, with the steam tracks on the side toward the Cuyahoga River. High-level, passenger-loading platforms are built between the rapid transit lines, while low-level platforms are in use for steam lines. On the station floor above the tracks, the same segregation has been carried out. Two concourses, each 62 ft. wide by 280 ft. long, located either side of the ticket lobby, with ample connections between, are provided for



EAST APPROACH CUT SEEN FROM THE TOWER

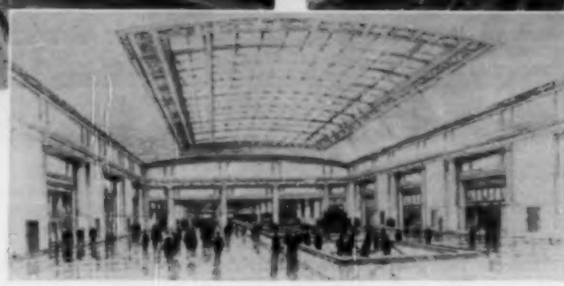


RIGHT OF WAY THROUGH EAST CLEVELAND



ELECTRIC LOCOMOTIVE REPAIR SHOP
Collinwood Power Change

STEAM LOCOMOTIVE TERMINAL
Collinwood



MAIN PASSENGER CONCOURSE

the rapid transit lines. The ticket lobby is 138 ft. long by 91 ft. wide with a grained ceiling 20′6″ high. The "steam" concourse is 120 ft. wide by 237 ft. long, with a segmental-arch ceiling $42^1/_2$ ft. above the floor at its crown and unobstructed by columns. This gives access to the steam tracks below by six separate stairways.

The main axis of the station and the tower lies north and south, at right angles to the tracks and through the main entrance from the Square. The entrance portico, 34 ft. wide by 152 ft. long, is one of the most beautiful rooms in the station building, finished in marble to the springing lines of its barrel-arch ceiling. From the entrance lobby, three of the five openings lead to the lobby of the tower building, while the two remaining side openings lead down the ramps connecting with the ticket lobby of the main steam concourse. Openings at each end of the entrance lobby lead into the two rapid transit lobbies, from which ramps lead to the traction concourses.

In addition to the spacious ticket lobby and concourses, the floor provides a baggage room and checking counter, telephone room, telegraph room, cab-stand entrance, mail and express space, lunchroom, restaurant, a food shops and bakery, a drugstore, and numerous concessionary cigar- and news-stands, men's and women's apparel shops, toy shop, a barber shop, and the usual space for the facilities which operate the station and rooms for the convenience of the employees. In fact, one of the features of the station is utilization of all surplus areas for interior shops.

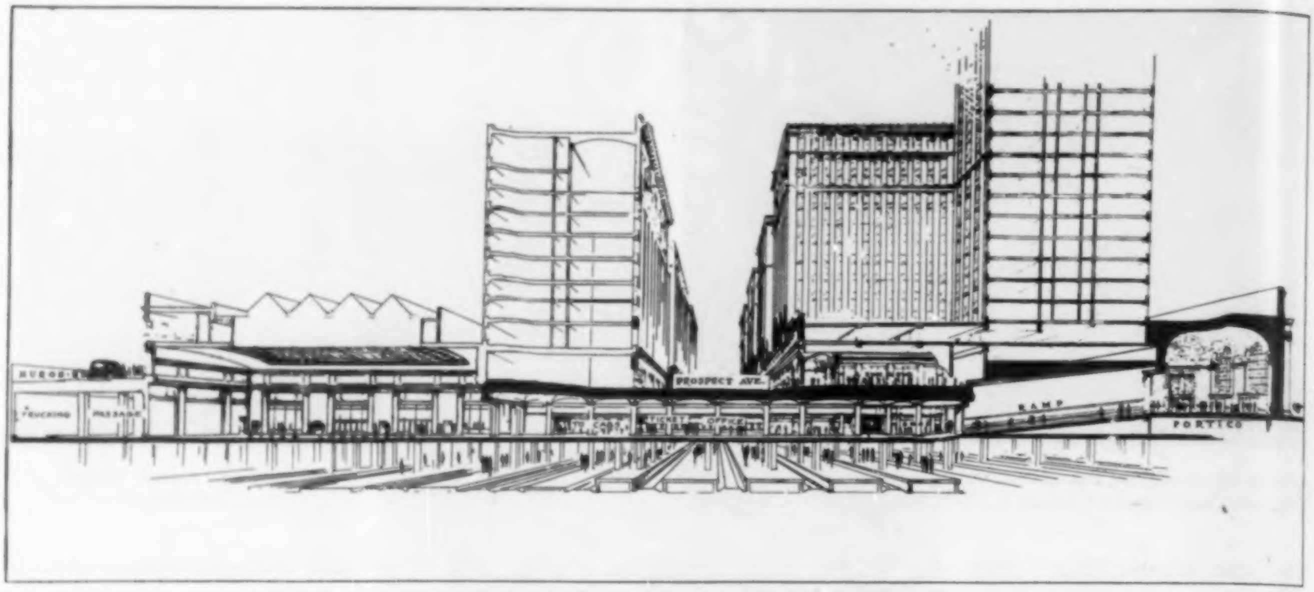
A separate corporation, the Cleveland Terminals Building Company, has built a number of impressive looking buildings over the station site. These are a skyscraper office building, called the Terminal Tower, and a group of 18-story structures flanking the tower—the Hotel Cleveland; a department store yet to be completed; the Medical Arts Building; the Builders Exchange and the Terminal Garage; and the Midland Bank. The construction of the foundations for these buildings proved a real engineering problem, which will be treated by Mr. Marsh.

APPROACHES REQUIRE HEAVY WORK

From the west the approach to the station was located so that the Nickel Plate and the Big Four could connect satisfactorily with it, and its grade was determined by the desire to cross the Cuyahoga River at a level high enough to permit the use of a fixed bridge. These con-

APPROACH CUT WEST OF CUYAHOGA VALLEY VIADUCT

CUYAHOGA VALLEY VIADUCT WEST FROM THE TERMINAL



CROSS SECTION OF THE STATION THROUGH THE WEST RAMP LOOKING WEST

siderations and the desire to interfere as little as possible with the city streets and the area served by them dictated the use of a viaduct 3,450 ft. long, extending from Columbus Road to Franklin Avenue, and crossing over nine city streets. The details of the building of this structure are also taken up by Mr. Marsh.

South of the end of the viaduct, the west approach enters a four-track cut, having a maximum depth of 30 ft. One of the illustrations shows two tracks in place and the type of overhead construction used for the catenary-hung contact wire. Another illustration shows a typical example of the center pole construction used on curves.

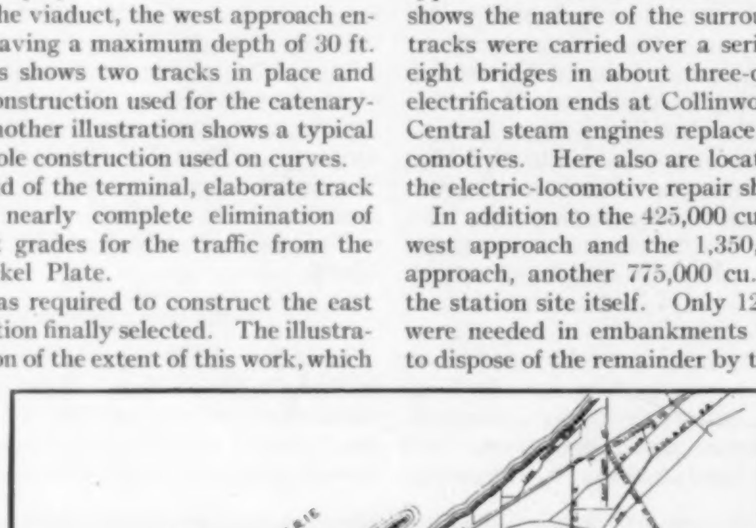
At the 25th Street end of the terminal, elaborate track arrangements provide nearly complete elimination of crossing movements at grades for the traffic from the Big Four and the Nickel Plate.

Heavy excavation was required to construct the east approach along the location finally selected. The illustrations give some indication of the extent of this work, which entailed a side-hill cut for several blocks; than a cut averaging 40 ft. deep for 10 blocks more, to East Fifteenth Street; and the remainder comprising largely side-hill work, where the excavation greatly exceeds the embankment.

Five streets and three railroads are carried over the east approach tracks, each structure presenting an individual, and often an intricate problem. For the present, three steam-line tracks and two rapid-transit tracks have been built here, but provision has been made in the structures crossing the cut for an ultimate expansion to nine tracks.

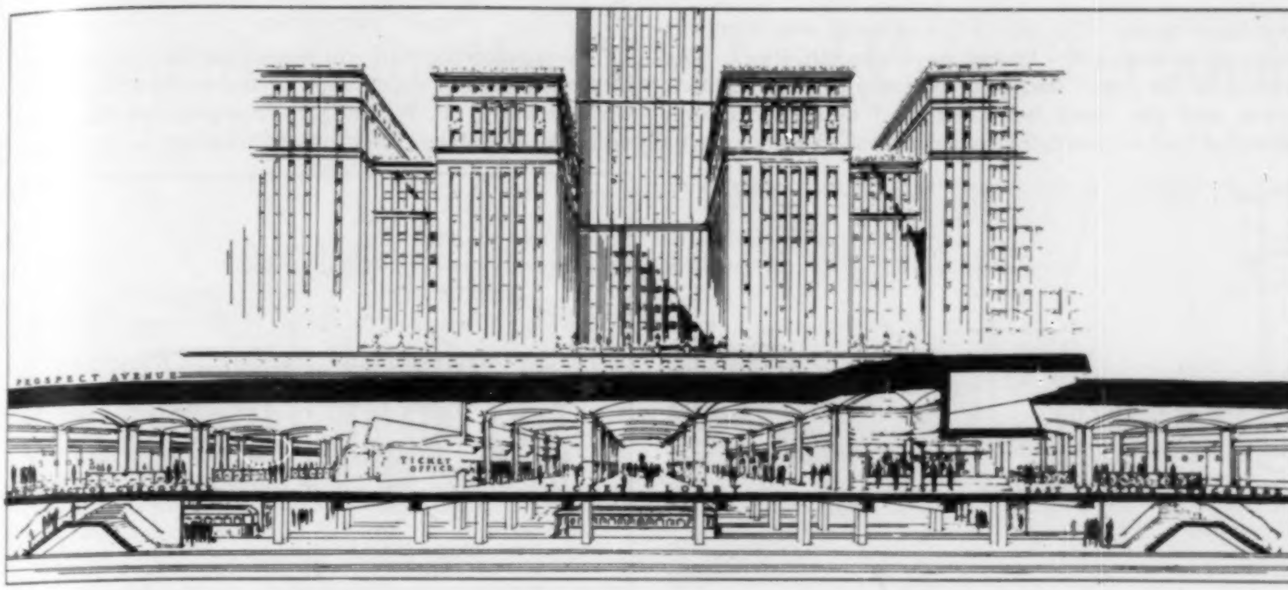
Beyond the limits of the terminal, at East 37th Street, the participating railroads carried on the necessary new track work and electrification. One of the illustrations typical of the construction through East Cleveland, shows the nature of the surrounding houses, where the tracks were carried over a series of streets, there being eight bridges in about three-quarters of a mile. The electrification ends at Collinwood, where the New York Central steam engines replace the terminal electric locomotives. Here also are located the engine houses and the electric-locomotive repair shops.

In addition to the 425,000 cu. yd. of excavation in the west approach and the 1,350,000 cu. yd. in the east approach, another 775,000 cu. yd. were removed from the station site itself. Only 125,000 cu. yd. of the total were needed in embankments so that it was necessary to dispose of the remainder by train haul or motor trucks. The contractors made their own arrangements for the disposal of the excess, a total of 2,425,000 cu. yd. Large capacity shovels and drag lines were extensively used.



CLEVELAND PASSENGER TERMINAL PLAN
Linndale to Collinwood

Because so much of the trackage is in cut, special attention has been given to track drainage, not only in the use of liberal depths of ballast, but by laying perforated 8-in. corrugated iron pipes in trenches, backfilled with broken stone and located between tracks and in the side ditches.



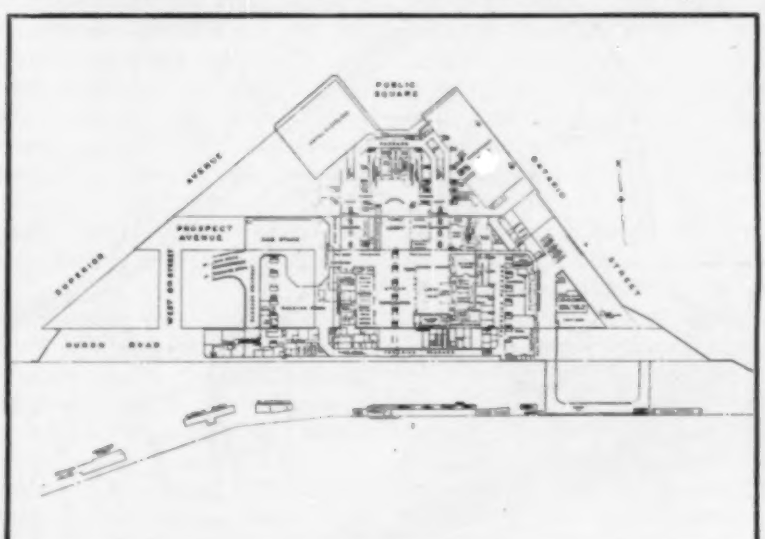
Cross Section of the Station through Prospect Avenue Looking North

Near each end of the electrified section, an automatic substation is located containing motor-generator sets for converting the Cleveland Electric Illuminating Company's 11,000-volt, 3-phase, 60-cycle alternating current to 3,000-volt direct current for transmission to the locomotives. The station at West 71st Street has a 9,000-kw. capacity while the station at the east end has a capacity of 6,000 kw.

In this project, for the first time in the United States where tunnel operation is not involved, a change to electric motive power has been required for hauling passenger trains through the city. There is no question that the absence of steam locomotive smoke and cinders will prove to be a welcome relief to Cleveland. This service requires the use of twenty-two, 204-ton, 3,030-hp. electric locomotives, each developing a tractive effort of 30,600 lb. and a maximum speed of 70 m.p.h. As may be seen from the illustrations, the electric locomotives receive their power from an overhead contactor.

Work Performed Under Contract

Numerous contracting firms carried on the construction work of this project, which extended over a period of eight years. The first large contract, that for the grading of the station site, was awarded to the Walsh Construction Company of Davenport, Iowa. It was followed by a contract given to Spencer, White, and Prentis, of New York, for the construction of the foundations for the tower and for most of the other buildings in the station area, including the Canal Road bridging and the Eagle Avenue viaduct. The Tower Building was constructed by John Gill and Sons, Cleveland, who also built the piers of the Cuyahoga viaduct. To the Aronberg-Fried Company of New York was awarded a general contract for the construction of the station building and all the facilities forming a part of the station. This company also built the Midland Bank Building, the Union Trust Bank in the Tower Building, and the electric locomotive shops and inspection sheds at Collinwood. The Terminal Garage and Builders Exchange Building and the Medical Arts Building were constructed by the Lundoff-Bicknell Company of Cleveland, as general contractors. On the approach cuts, the principal grading and masonry contractors were the Walsh Construction Company, The Bates and Rogers Company, the Cleveland Excavating Company, the H. E. Cubertson Company, A. Guthrie and Company, the Herkner Motor Trucking Company, and the Hecker-Moon Company.



Floor Plan of the Station at Concourse Level
New Streets Indicated

Walworth Avenue Bridge

An example of the many difficulties which came up in connection with various phases of the work was the problem encountered west of the 25th Street station of the New York, Chicago and St. Louis line, where the tracks of this road cross Walworth Avenue, the Big Four and the terminal tracks at a 30

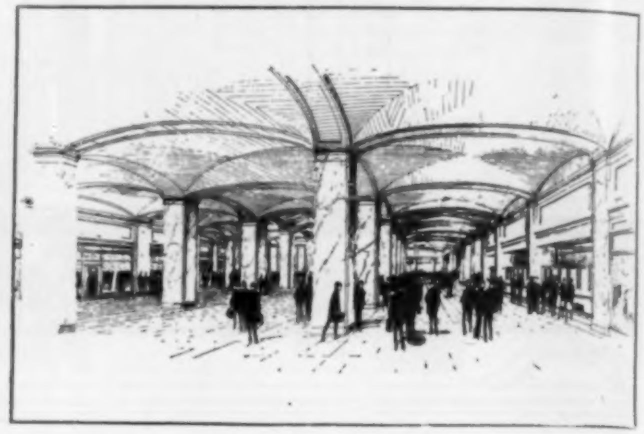
deg. skew angle. The site of the crossing structure was formerly a deep gully known as Walworth Run. The waters of the creek had been enclosed in a 15-ft. brick sewer and the creek bed then used as a city dump. Material had accumulated to a depth of 25 feet.

TYPICAL OVERHEAD, CENTER-POLE CONSTRUCTION

Excavation through this mass of every imaginable kind of municipal rubbish disclosed the foundations of these or four bridges of various types which had been previously built and abandoned. Underneath all the tracks and running through the fill was a 24-in. gas main that had to be maintained. Fifty cylindrical piers excavated through the rubbish and founded on the underlying clay, were placed to clear the obstructions and the structure above was then designed to fit them. On top of the 60-ft. piers a steel girder bridge with a reinforced concrete deck was built.

PERSONNEL

The engineering staff which assisted the chief engineer in the design and supervision of the construction of the work includes: F. W. Badger, Principal Assistant Engineer; W. L. Falvey, Engineer of Buildings; C. P. Marsh,



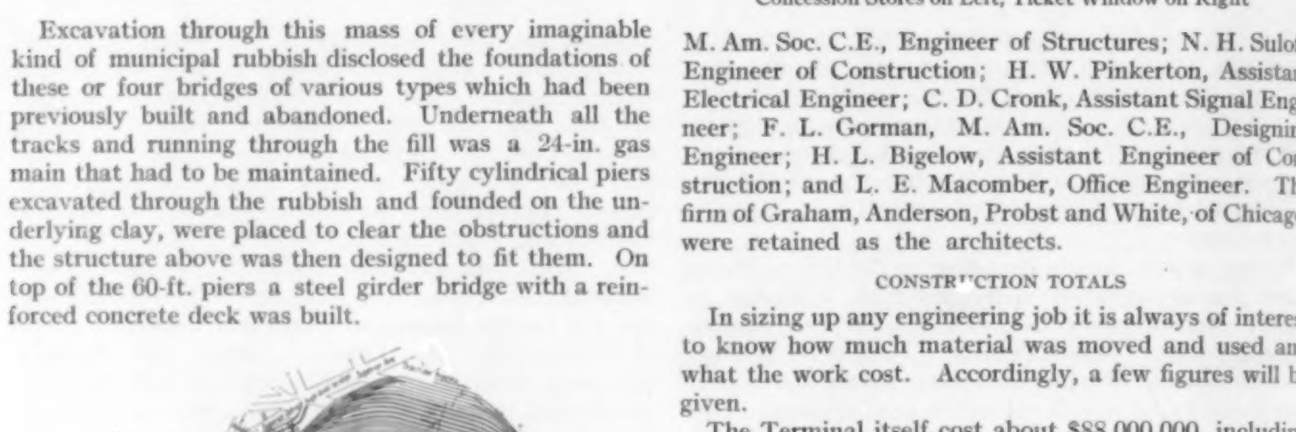
THE TICKET LOBBY
Concession Stores on Left, Ticket Window on Right

M. Am. Soc. C.E., Engineer of Structures; N. H. Suloff, Engineer of Construction; H. W. Pinkerton, Assistant Electrical Engineer; C. D. Cronk, Assistant Signal Engineer; F. L. Gorman, M. Am. Soc. C.E., Designing Engineer; H. L. Bigelow, Assistant Engineer of Construction; and L. E. Macomber, Office Engineer. The firm of Graham, Anderson, Probst and White, of Chicago, were retained as the architects.

CONSTRUCTION TOTALS

In sizing up any engineering job it is always of interest to know how much material was moved and used and what the work cost. Accordingly, a few figures will be given.

The Terminal itself cost about $88,000,000, including electrification, electric locomotives, land carrying charges, and other items. In addition to that, the building construction now carried out or under way will cost about $31,000,000, and the railroad improvements which were necessitated by the changes about $40,000,000, so that, in the past few years, there has been invested between $150,000,000 and $160,000,000 in Cleveland. In addition to the excavation materials given above, there were handled about 500,000 cu. yd. of concrete and 100,000 tons of steel work.



PLAN OF CLEVELAND UNION TERMINAL TRACKAGE

Foundations for the Cleveland Union Terminal

Buildings, Bridges, and Structures Offer New Problems

By C. P. Marsh

Member American Society of Civil Engineers

Engineer of Structures, Cleveland Union Terminals Company, Cleveland, Ohio

INTRICATE and difficult engineering problems, due to unfavorable topography, were involved in the construction of Cleveland's new Union Terminal. The great cost of extending footings for the 52-story tower, 204 ft. below rail level, warranted extreme care both in making physical-bearing tests and in scrutinizing every possibility of founding the buildings at some shallower depth. How all these problems—both of highway and railway transportation—have been solved may be judged from this abstract of Mr. Marsh's paper. The original was read before a combined meeting of the Construction and Structural Divisions of the Society at the Cleveland Convention, July 10, 1930.

CLEVELAND'S Union Terminal, participated in by the three railroads, the New York Central, the Big Four, and the Nickel Plate, was made possible by a cooperative financial plan whereby they become stockholders in the Cleveland Union Terminals Company, and they guaranteed the construction bonds issued by the Company. Air-right utilization of the space above the terminal for office buildings not only made the financing possible, but also required the electrification of the entering railroads, involving 17 route miles of electrified lines between Collinwood on the east and Linndale on the west. Buildings over the station site were constructed by a separate corporation, the Cleveland Terminals Building Company.

As a preliminary to the work of constructing the foundations of the structures and the 52-story tower of the Cleveland Union Terminals Company, test holes to the amount of 8,000 lin. ft. were driven. Samples were submitted to the United States Government Bureau of Soils. For example, one sample reported on showed that 19 per cent of the material was very fine sand with grains varying from 0.1 to 0.05 mm. in diameter; 67.2 per cent was silt with grains varying from 0.05 to 0.005 mm. in diameter; and 13 per cent was clay with grains smaller than 0.05 mm. The engineering literature on the subject was searched for information concerning the design of structures supported on clay foundations. Considerable assistance was obtained from the study of tests made by Arthur Langtry Bell, published in Vol. 199 of the *Minutes of Proceedings* of the Institute of Civil Engineers, 1914–1915. The engineers of the Cleveland Union Terminals Company also conducted a series of direct-load tests on samples of clay taken from different test borings.

In order to do this, a machine was constructed, as illustrated, which consisted of a wooden box, 1 cu. ft. in size, a plunger 4 in. square, and a weighted lever to apply the load. The clay from a test boring was packed into the box as solidly as possible and leveled off. Loads were added and observations made of the settlement of the plunger until the settlement ceased; additional load was then applied and further observations taken as to settlements. These tests gave results which indicated that each application of load would be accompanied by settlement, which would, in time, cease.

At a later date, when some buildings had been wrecked at locations where the clay soil could be exposed with but little digging, a field test was made at a point between Superior Avenue and former Champlain Avenue and a short distance east of West 6th Street. This test was made by means of a plunger 3 ft. square, supporting a timber platform about 12 ft. square, which was loaded with pig iron. The test was continued for a period of 69 days, the load per square foot being increased in 1-ton units from 0 up to 7 tons. With each application of load, there was an increase in settlement, generally more rapid than the change in loading.

On the basis of this and other tests it was decided that a maximum bearing pressure of 3 tons per sq. ft. could be assumed for the retaining walls and foundations.

THE TOWER BUILDING

A decision to build a 52-story tower in connection with the new Union Station necessitated a number of changes in the foundation design from the original proposals. A preliminary design for a mat foundation supporting the tower, with a unit bearing pressure on the soil of 3 tons per sq. ft., gave a mat of such dimensions as to interfere with the foundations for columns exterior to the tower. Indeed, so high was the cost of this that it was dismissed from further consideration. The alternative seemed to be to adopt the type of foundation used extensively in Chicago, that is, cylindrical piers built in open wells and carried deep down into the earth.

There the soil immediately beneath the basements, which extend down about 60 or 70 ft., is generally a soft, plastic clay. Below this there is a material which is locally termed "hardpan," a hard, compact clay mixed with gravel of such compactness that, subject to test, loads as high as $7^1/_2$ tons per sq. ft. are permitted on it.

Under the site of the Terminal Tower Building, however, the blue clay was fairly well stratified. Some layers were dry and fine or even hard, and some contained blue sand or pebbles, while immediately above the bedrock was a water-bearing stratum containing many rocks, showing distinct indication of glaciation. Some of the strata had a slight odor of mould and other signs of the presence of organic material. The clay was very dense, and several samples averaged 133 lb. per cu. ft. in weight.

FIELD BEARING TEST ON CLAY
Prepared hole, upper left; bearing block, upper right; loaded platform, below.

Because of its height, the tower caused an excessively large overload to be concentrated on an area about 100 ft. square, and to accommodate railroad tracks this load had to be carried on but 16 columns. The task of determining the design of the cylindrical foundations and allowable bearing pressure on the soil was an interesting one. The question of skin friction of the surface of a cylindrical pier had to be solved, and for this purpose the engineers reviewed the similar experience in the Pennsylvania Terminal at Chicago where a pier 4 ft. in diameter, extending 70 ft. into blue clay, was undermined and then loaded so as to cause it to slip.

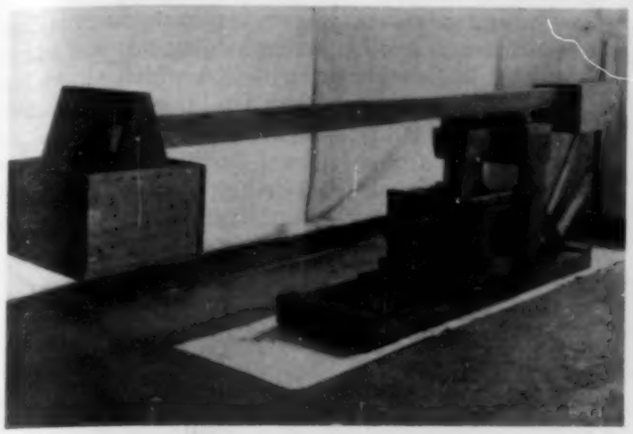
BEARING POWER OF MATERIALS DETERMINED

After considerable discussion among the engineers connected with the Cleveland project and others who had had wide experience with such foundations, it was finally decided to use an allowable unit bearing pressure on the clay in pounds per square foot equal to 110 times the thickness in feet of the soil layers above the plane of the bottom of the foundations, plus 3,000 lb. when skin friction was considered, but limiting the total maximum to 15,000 lb. per sq. ft., when skin friction was ignored.

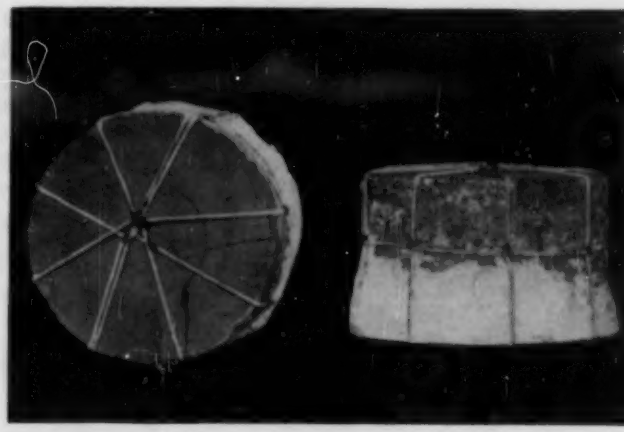
DEEP-WELL EXCAVATIONS FOR TOWER FOUNDATIONS

To determine what load could safely be imposed upon the bedrock, in case it was necessary to carry the foundations down to rock, the following test was made.

A piece of the rock core, which was approximately $2^5/_8$ in. in diameter and $1^1/_4$ in. deep, was leveled up with rich cement mortar and mounted in plaster of paris in a testing machine. A load was applied on top of this piece of rock core, in 100-lb. increments, by means of a round plunger having an area of 1 sq. in. There was no indication of failure of the specimen until the unit pressure reached 4,500 lb. per sq. in., at which time a slight hair crack appeared on one side. The load was increased until it reached 6,500 lb. per sq. in., when a second small crack appeared on the opposite side of the specimen from the first crack. No further change occurred under additional load until the load reached 7,100 lb. per sq. in., at which time the second crack opened up



Testing Bearing Power of Clay Samples



Rock Core after Compression Test

slightly. There was no change with additional load up to 7,600 lb. per sq. in., when the first crack opened up further. At 7,700 lb. the top of the specimen began to crack. The test was terminated at this point to save the specimen. The load of 4,500 lb. per sq. in., at which the first crack appeared, is equivalent to 316 tons per sq. ft. Allowing for differences between the actual condition of the foundation rock in place and the specimen tested, it was determined that a bearing pressure of 100 tons per sq. ft. was perfectly safe.

Where they rested on clay, the bottoms of the piers were designed with bells consisting of truncated cones with their surfaces sloped two on one. The tower foundations carry loads varying from 6,300,000 to 8,900,000 lb. and are from 8 ft. 8 in. to 10 ft. 4 in. in diameter. In designing the belled cylindrical piers, resting on clay, the total load to be supported was assumed to be the weight of the superstructure, the pier, and the bell; and the supporting items were the skin friction on the sides of the pier shaft, at 350 lb. per sq. ft., and the sustaining power of the clay beneath the bells. This latter was dependent on the quality of the material and its distance from the surface of the ground. The allowable soil pressure beneath the bells at the depths to which the foundations were carried was finally fixed at $5^1/_2$ tons per sq. ft., with an alternate limit of $7^1/_2$ tons per sq. ft., providing the skin friction was ignored.

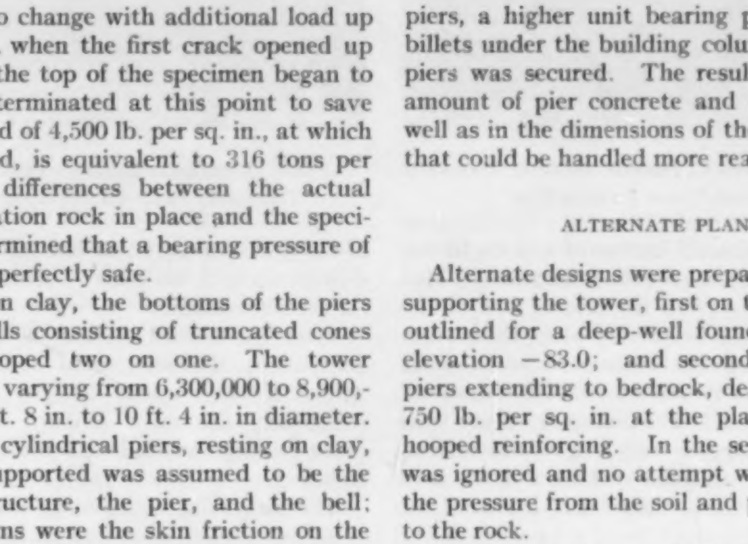
No shaft less than 4.0 ft. in diameter was used on account of the difficulty in excavating one of smaller diameter; and where the unit stress in the concrete of a 4.0-shaft was 400 lb. per sq. in. or less, the pier below the hooped reinforcing was made of concrete having about a 1:2:4 mix.

By the use of high-strength concrete for piers, a higher unit bearing pressure between the steel billets under the building columns and the tops of the piers was secured. The result was a reduction in the amount of pier concrete and foundation excavation as well as in the dimensions of the bearing billets to a size that could be handled more readily.

Alternate Plans Prepared

Alternate designs were prepared for the 16 foundations supporting the tower, first on the basis of bearing values outlined for a deep-well foundation resting on clay at elevation −83.0; and second, for cylindrical concrete piers extending to bedrock, designed for a unit stress of 750 lb. per sq. in. at the plane of the bottom of the hooped reinforcing. In the second design, skin friction was ignored and no attempt was made to conceive how the pressure from the soil and piers might be distributed to the rock.

Bids were taken on both designs. While the bid for the first design, terminating the shafts with bells at elevation −83.0, was considerably lower, the management of the Terminals Building Company decided that complete safety and the resulting moral effect on the tenants justified the additional expenditure of carrying the foundations to rock, approximately at elevation −155.0, a total depth of 204.0 ft.



The Cleveland Union Terminal
Trackage, Viaducts, and Buildings

One of the illustrations shows the deep wells under the tower. The sides of the wells are supported by tongue and groove hard-wood lagging, held in place by steel rings, the segments of which are secured to one another by bolts and forced apart by wedges. Excavation was carried down in 6-ft. sections and the lagging set in place as rapidly as the

hole became deep enough. Neither lagging nor rings were removed from the wells while concrete was being poured, it being always considered that in sacrificing the material enough time was saved in speed of construction to justify the loss.

EXCAVATION CAUSES SUBSIDENCE

During the construction of the deep-well foundations,

SOLVING SOME OF CLEVELAND'S TRANSPORTATION PROBLEMS
View from Terminal Tower Looking East

a general subsidence of several inches of the earth occurred over a restricted area adjacent to the work. This was thought to be due largely to the lateral flow of the deep clay strata in which the wells were being excavated. A small clearance between the excavated earth walls and the lagging at the time it was set probably also contributed to this settlement. Furthermore, there was also the yielding of the lagging and rings under stress. It was found that the boundaries of this affected area bore a definite relation to the positions and depths of the wells.

By drawing circles concentric with each deep well excavation, at radii equal to one-half the depth of the bottoms of the wells, below the subsided area, it was found that there was very close agreement between the number of the circles overlapping at one point and the amount of settlement observed, thus corroborating some important findings of H. C. Moulton, published in *Transactions of the American Institute of Mining and Metallurgical Engineers*, 1920. Cost of these foundations was approximately $1.25 per cu. ft. Gas was found in nearly every well, and one explosion resulted.

FINAL BEARING TESTS MADE

At the time the foundation wells for the tower building reached sufficient depth to uncover clay of a nature such as might be expected at the bottom of the foundations, numerous clay tests were taken.

Among other tests a steel ball $1^5/_8$ in. in diameter was dropped a distance of 24 in. and the imprint made in the soil specimen measured. The soil was not considered satisfactory to sustain a load of 3 tons per sq. ft. under spread footings if the imprint exceeded 1.03 in. in diameter.

It was considered desirable both from the standpoint of cost and speed of construction to use the spread-footing type of foundation wherever possible. After the first section of the Tower Building was practically complete and no further movement was evident in the surrounding soil or structures, another direct loading test was made on the clay soil at elevation +43.5 which showed a settlement of a little more than $^3/_{16}$ in. under a load of 12,000 lb. per sq. ft. It was therefore decided to place the second section of the Tower Building and all other buildings to be constructed on spread footings, with bottoms on suitable clay soil using an allowable pressure

CUYAHOGA RIVER SPAN DURING ERECTION
Temporary Holdback Members Eliminate Falsework

of 6,000 lb. per sq. ft. on the soil except where local conditions made it necessary to resort to deep foundations for certain columns.

After the second section of the Tower Building was completed, the settlement readings showed that the spread footings under this part of the building settled practically the same amount as the deep cylindrical piers, resting on soil, constructed for either section of the building.

The largest spread footing constructed in the station is 32 by 41 ft. in area and carries a load of 6,300,000 lb. The foundations in the station area support approximately 1,000 columns and contain approximately 74,000 cu. yd. of concrete and 3,100 tons of reinforcing steel.

CUYAHOGA VIADUCT

The construction of a 3,400-ft. viaduct across the Cuyahoga Valley, to accommodate four tracks at one end and five at the other, is an integral part of the Cleveland Union Terminal development. This viaduct constitutes the westerly approach to the Terminal and carries both eastbound and westbound tracks. In general, the structure consists of deck plate girders of varying span lengths up to 125 ft. The main span over the Cuyahoga River is a through truss span 270 ft. in length from center to center of bearings. The viaduct has a solid concrete deck throughout. Those piers that were designed to rest directly on the clay were allowed a soil pressure of 6,500 lb. per sq. ft.

HARDWOOD PILES USED

Twenty-two of the piers were constructed on timber piles while the two river piers were supported on deep cylindrical foundations resting on bedrock. The piles used were hardwood, generally oak and about 50 ft. long, planned for a load of 30 tons per pile. They were driven with a single-acting, steam pile hammer, weighing

9,000 lb. with the striking parts weighing 5,000 lb., and having a maximum stroke of 36 in. It was desired to develop such a resistance in driving the piles that the total settlement under the last ten blows would not exceed $2^1/_2$ in. Some of the piles did not develop that resistance before the butt reached the desired cut-off elevation. By the time another pile had been spliced to it, it was found practically impossible to start it again. It was, therefore, decided that in similar cases the pile driving should be suspended for about an hour to permit the soil to settle around the pile and that if the desired resistance occurred after that time, that pile would be considered set.

CANAL ROAD BRIDGE
Cleveland Electric Illuminating Company's Plant at Right

CUYAHOGA RIVER SPAN

Probably the most interesting feature of the entire viaduct structure was the building of the river piers. Borings made by the Terminals Company indicated that bedrock would be found at about elevation −103.0 and also that, if tight sheeting were driven through the upper strata to exclude the water, the excavation below that point could be made by open-well methods. After careful consideration, it was decided to carry the foundations for the two piers of the river span down to rock.

The upper portion of these piers consists of two heavy, massive arches, the shafts of which are about 10 ft. by 19 ft. at the base. The footings for these consist of heavily reinforced ribs transverse to the pier and about 10 ft. by 30 ft. in area under the end shafts, and 10 ft. by 40 ft. under the central shaft. Each of these ribs is 15 ft. deep and the two end ribs and central rib are tied together by heavily reinforced struts 5 ft. and 7 ft. deep, the over-all length of the footings being 72 ft.

FOUNDATIONS 95 FT. DEEP

At the bottom, these footings are about 8 ft. below the surface of the river and rest upon cylindrical piers that extend down to the blue Cuyahoga shale at a depth of about 95 ft. below the river on the west bank, and about 100 ft. on the east bank. Under the end shafts of each pier there are three cylindrical piers, spaced 10 ft. from center to center transverse to the pier, and under the central shaft there are four cylindrical piers, spaced 10 ft. on centers transverse to the pier. The longitudinal spacing of the three sets of cylindrical piers under each pier is 30 ft. $10^1/_2$ in. on centers.

On the east or north bank, the river pier is on level ground and at present there is little likelihood of unbalanced pressures against the pier, but in the future, unless otherwise provided for, an unbalanced earth pressure is likely to develop due to proximity of the future river channel. Consequently, the cylindrical piers, which are 5 ft. 0 in. in diameter, are reinforced for a distance of 45 ft. below the bottoms of the footings, to take bending and to transfer and distribute the lateral forces well down below the bed of the river.

CUYAHOGA VIADUCT UNDER CONSTRUCTION
Detroit-Superior Bridge in Background

VIADUCT DESIGNED FOR COOPER'S E-70 LOADING

The concrete deck on the viaduct is a continuous reinforced-concrete slab over the full width and length of each span, except that in the case of the river span it is divided in two by the center truss. The live loading used was Cooper's E-70, plus half the impact allowance specified by the New York Central Railroad Bridge Specifications for Steel Railroad Bridges.

The distribution of the live loads to the deck and through that to the girders was the subject of considerable study. Two different analyses were used. First, it was assumed that the cross frames had infinite vertical and lateral stiffness and thus maintained a straight, but not necessarily a horizontal line under all conditions of loading; second, that there was a definite value for the moment of inertia of the cross frames. The general three-moment equation was used in both instances.

Mainly, the second analysis was made for designing the reinforced-concrete deck slab, and further to check the results obtained with the first assumption. The first analysis produced somewhat higher stresses in the girders and cross frames and the results obtained were used, in the case of the cross frames, to design them, and in the case of the girders, to develop an empirical method of design.

TWO ANALYSES MADE

In the development of this empirical method two solutions were made; the first based on the general three-moment equation, and the second on the same equation modified by the assumption that the cross frames remained straight. The second method was much shorter and simpler, and the results obtained by the two methods were practically identical. The second analysis gives a curved elastic line for the frame and results in the design

of a slab which is continuous over multiple supports not on the same level.

From this study results were obtained considerably different from those reached by the usual three-moment analysis, which would only be applicable at the piers where no girder deflection occurs. The slab was also analyzed for this condition of level supports, and the maximum stresses obtained from either method were used in the design of the slab. Expansion joints were provided between the spans at each pier.

BRIDGING CANAL ROAD

Near the eastern limit of the station, the steam railroad tracks cross an angle in Canal Road where it turns about 54 deg. Canal Road is a 48-ft. street west of the angle, and a 66-ft. street east of the angle. The pavement is about 21 ft. below the top of the rail of the terminal tracks. It was, therefore, necessary to construct bridging over the street roughly triangular in shape and approximately 12,000 sq. ft. in area.

There were certain factors that exercised a large influence upon the design that was finally adopted. It was desired to keep the roadway free of columns. Canal Road in front of the Cleveland Electric Illuminating Company's plant was full of public utilities, including a number of duct lines leading away from the plant, and it was hard to find room for any foundations in the street. In addition, it is about 60 ft. lower than Ontario Street, which is 100 ft. distant at the closest point, and in that distance it was necessary to maintain tracks and construct retaining walls for the support of Ontario Street. The ground in the vicinity was reputed to be unstable.

Fourteen feet of headroom between the street grade and the underclearance line at the bottom of the main girders, 7 ft. below rail level, was provided for in the design. As may be seen in the illustration of the completed structure, all structural steel members are encased in concrete in order to protect against fire, to enhance the appearance of the structure, and to obviate the necessity of painting. The main structural columns are H sections, the heaviest being 16 in. and having a weight of 427 lb. per ft.

Cylindrical pier foundations were carried down 50 ft. below street level with the bells resting on good stiff clay. The retaining wall along the north line of Canal Road, which supports Ontario Street, has a foundation of cylindrical piers. An arrangement of footings was adopted to provide openings for carrying down foundations for future buildings where the track layout permitted. The cost was estimated to be about the same as that of a wall carried on concrete piles.

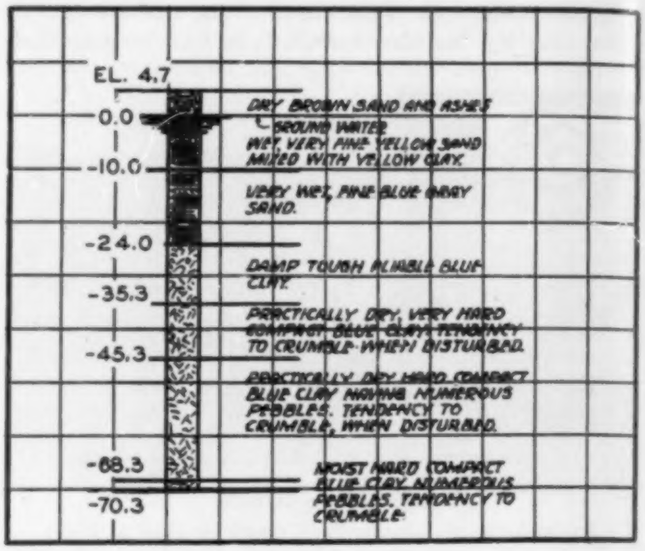


DIAGRAM OF LOG OF TYPICAL TEST HOLE
Cuyahoga Viaduct

OTHER STRUCTURES

An idea of the extensive reconstruction due to grade separation adjacent to the Terminal Building may be gained from the photograph showing a view to the east. Bridges, viaducts, subways, and river crossings were here involved. Besides the problems in transportation, intricate studies of foundation conditions and design were presented for solution. How great were some of these difficulties and how they were overcome has been indicated. Reviewing the structural difficulties of the entire project, especially with reference to foundations, the results obtained are believed to justify the methods adopted.

Shaker Heights Develops Interurban Railroad

Rapid Transit Serves Cleveland's Largest Suburban Development

By WILLIAM E. PEASE

ASSOCIATE MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
CHIEF ENGINEER, CLEVELAND INTERURBAN RAILROAD COMPANY

SURROUNDING Cleveland, within a radius of 10 miles, the topography consists of two plateaus and the stream channels cut through them. The lower plateau, on the shore of Lake Erie, is from 70 to 90 ft. above the lake level, and extends inland some five miles, gradually rising to an elevation of 130 ft. The upper plateau rises rather abruptly to a height of about 250 ft. and then slopes gently upward, rising about 25 ft.

per mile. The break in the terrain between these two plateaus led to the development of the lower level plateau toward the east and northeast along the lake, while areas much nearer the center of the city, but on the higher level, remained farm land.

About 1908, some 1,600 acres of this farm land passed from the ownership of the Shaker Community to the Van Sweringen interests. This property, just outside of, but bordering on the city limits, located six miles east of the Public Square, abutted on the then unimproved parkway property of the Cleveland Metropolitan Park System.

SELDOM does the simple development of a choice piece of suburban land expand step by step into the construction of a high speed electric interurban system, and then into a great freight yard and union passenger terminal plan. But in Cleveland this apparently happened. The Shaker Heights operations, begun in 1908, have since resulted in the construction of the Cleveland Interurban Railroad and now in the completion of a great union terminal. A long and close association with these developments peculiarly qualifies Mr. Pease to complete the reader's mental picture of a project which required vision, courage, money, and cooperation. This is a résumé of his paper, which was read before the Society at its Cleveland Meeting, on July 9.

TRANSPORTATION REQUIRED TO DEVELOP PROPERTY

In adopting a suitable plan of main highways for the area, it soon became apparent that a rapid transit line was its greatest requirement. Because the haul was long and population small, the officers of the Cleveland street car system could not be interested. But by increasing the original 1,600-acre holding to 4,000 acres, it was believed by the owners that the expense of an independent, high-speed railroad on private right of way would be justified. Accordingly, steps were taken to purchase suitable adjacent property and, at the same time, to survey a railroad route and acquire the necessary right of way. Early in 1912, an agreement in ordinance form had been reached between the City of Cleveland and the company organized to operate the rapid transit line, the Cleveland and Youngstown Railroad Company, as to the manner of handling the separation of street grades from the tracks. The rapid transit line has steam railroad charter rights, and there are no grade crossings in the City of Cleveland.

Adjacent to the parkway the property was subdivided first into large estates and into lots with frontages of from 100 to 200 ft., while after the rapid transit features were developed, 50- and 60-ft. lots were laid out. This naturally had led to the development of beautiful estates along the parkways and beautiful but more modest homes on the smaller lots, all sections being carefully restricted, with the right to approve or reject building plans reserved by the developers in the purchaser's deeds.

PRIVATE RIGHTS OF WAY OBTAINED

The main boulevards serving the Shaker Heights development are Shaker Boulevard and South Moreland Boulevard, the traffic being divided practically equally between them. Private rights of way and depressed double tracks were obtained in Shaker Heights to permit freedom of car and train movements. Reducing stops to an average of three in each mile made it possible to have only three overhead street crossing structures in the same distance, with no resulting inconvenience to any resident in the area served, as the increased speed and safety of train operation were of benfit to the passengers.

From East 37th Street to East Ninth Street, a distance of over a mile, the survey for the Cleveland and Youngstown Railroad serving Shaker Heights paralleled the main line of the Nickel Plate. The Nickel Plate is located 40 ft. below the general level of the city, and it traverses the residential section in an easterly and westerly direction—two disadvantages. As both lines need room for expansion and the Nickel Plate is anxious to provide high level freight and warehouse facilities, negotiations between these lines resulted in the purchase of a controlling interest in the Nickel Plate by the Van Sweringens.

In 1915, the city, the New York Central, the Big Four, and the Pennsylvania Railroad had reached an agreement to build a new passenger station on the lake front to replace the old Union Station at the foot of West Ninth Street that had been in use for over half a century. Neither the Erie, the Baltimore & Ohio, the Wheeling, the Nickel Plate, nor the Cleveland & Youngstown were parties to this contract.

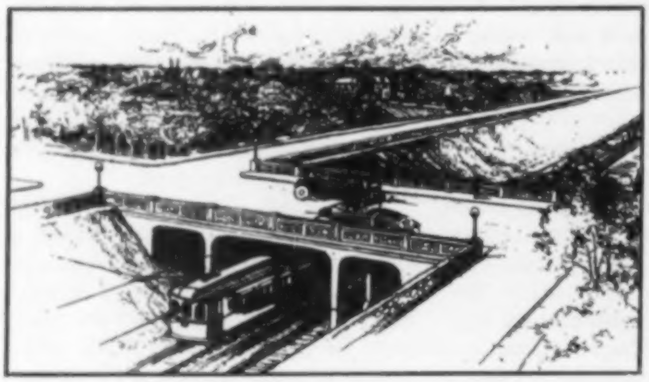
All the freight terminals in the downtown section were then located either along the Cuyahoga River or along the lake shore, with street approaches to the business district on grades up to 10 per cent. In search of a location for a high-level freight terminal and for improved passenger facilities in the operating of railroads and rapid transit lines that were not parties to the lake-front passenger-station contract, joint studies were initiated by the rapid transit owners. The Baltimore&Ohio, however, did not participate in these studies.

The studies resulted in the selection of an old residential area consisting of 20 acres on the general level of the city between East 15th Street and East 34th Street, which had degenerated into a slum district, for joint freight and warehouse facilities. Plans for a stub-

Woodhill Road Bridge
Constructed by Tunnel Method

end passenger station were developed for a site now occupied by the easterly third of the present Union Passenger Station. This structure is adjacent to the Public Square.

Then came the World War, which brought out the



TYPICAL RAPID TRANSIT CROSSING IN SHAKER HEIGHTS

weaknesses of transportation systems. The New York Central, lined on either side by large industries, had such a volume of passenger business that it could not provide adequate switching facilities for its industries. A switch engine on the Cleveland Short Line, the freight-handling subsidiary of the New York Central, could switch five or six times as many cars as could be switched on the main line.

The late A. H. Smith, once Federal Regional Director of Railroads, suggested the complete removal of the passenger business from the congested industrial area, and, in so far as possible, the provision of independent tracks for this service. He further suggested that the feasibility of using the proposed stub-end passenger station as the east approach for a through passenger station, with approach from both the east and the west, should be considered. As a result of these investigations, Cleveland's through Union Passenger Station plan was conceived in 1918 in the manner told by Mr. Jouett, and the stub-end plan for a station was abandoned.

Construction work on the rapid transit line was begun at Shaker Heights. In order to interfere as little as possible with the street traffic, a high pressure gas main, a city water main, and the operation of a crosstown surface car line on Woodhill Road, the grade separation at this point was constructed by tunneling under the street through rock and shale material. An idea of the method used and the resulting structure is given in the accompanying illustration. The construction of this line involved the building of 28 street and railroad crossings, those in the Shaker Heights residential area being of the type illustrated.

Because of the location of railroad yards, buildings, and

PART OF STRUCTURE OVER PENNSYLVANIA RAILROAD
Holton Avenue and East 90th Street

large manufacturing plants, the interurban crosses the Pennsylvania Railroad at its junction with East 90th Street and Holton Avenue. Due to the restricted area available to work even here, these two streets and the Pennsylvania Railroad are crossed on a continuous structure. It consists of concrete arches and deck plate girders supported on a cross girder spanning the streets; while a through riveted truss crosses the Pennsylvania tracks.

The joint construction work for the freight yard, the warehouse facilities, and the adjacent rapid transit line could now be commenced. The work involved the razing of buildings of the class shown in the illustration, the moving of approximately 250,000 cu. yd. of excavation, and the construction of a drainage system in Kingsbury Run with culverts up to 9 by 10 ft. in cross section. A total of \$20,000,000 has been invested in the rapid transit facilities for Cleveland.

The contract for the use of the Cleveland Union Terminal provided station facilities for rapid transit service in the station proper as well as approaches east and west for about 2 miles. Shaker Heights trains are now operating into the terminal, and the line along the Nickel Plate will be in operation before the first of the year 1931, when the Cleveland Interurban Railroad becomes an operating entity. I was assisted in the direction of the design and construction by Wilbur J. Watson, M. Am. Soc. C.E., Engineer of Structures, and by the late Samuel Rockwell, M. Am. Soc. C.E., Consulting Engineer.

CHARACTER OF BUILDINGS REMOVED IN DOWNTOWN AREA

UNIVERSITY SCHOOL GROUP IN SHAKER HEIGHTS

Practical Operation of Sewage Works

NOTABLE REPORT AND DISCUSSIONS
FEATURE DIVISION MEETING AT CLEVELAND

SANITARY engineers, sanitary chemists, and sewage works operators seem to be an active group of interested zealots who have produced a strange language and technical terms confusing to the uninitiated. This report and its discussion, presented at the Cleveland Meeting of the Division, in July 1930, and here abstracted, are written in terms understandable to most of the profession. They represent an attempt to standardize and improve practice in sewage works operation in order to produce better results and reports intelligible to all sanitarians. The report brought out discussion contributed by eight experts specializing in the subjects covered. Those offering discussion were: C. B. Hoover and Langdon Pearse, Members Am. Soc. C.E.; L. H. Enslow, W. D. Hatfield, and C. C. Hommon, Assoc. Members Am. Soc. C.E.; and Messrs. C. K. Calvert, A. H. Goodman, F. W. Mohlman, and C. E. Wheeler, Jr. The Committee's recommendations with regard to the supervision and financing of sewage works operation elicited the most active discussion.

Sanitary Engineering Division Hears Final Committee Report

PROGRESS in the art of designing and constructing sewage works has reached the stage where municipal sewage can be treated adequately in order to produce an effluent of any reasonable degree of purity. The operation of such works, however, has not kept pace with the advances made in their design. A recent survey indicates that many of them are poorly operated, with the result that the welfare and health of many communities are endangered. The outstanding reasons for the unsatisfactory operation of sewage treatment plants are the lack of sufficient operating funds and the need of well-trained and efficient personnel. The purpose of this report is to outline the underlying principles which it seems necessary to follow to insure the satisfactory operation of sewage works.

In considering these principles, five points have been covered, as follows:

1. State supervision of sewage works
2. The provision of adequate finances
3. The qualifications, compensations, and training of sewage works superintendents
4. Laboratory control of operation
5. The keeping of records and the making of reports

Satisfactory operation of sewage works can be approached by providing State control through a State board with adequate statutory powers, together with necessary finances and personnel, to approve the design and to control the operation of plants. The law in Ohio is an example of the legislation necessary to accomplish this purpose.

WHO SHOULD PAY OPERATION COSTS?

The financing of a sewage plant is one of the most important factors affecting its successful operation. Most municipally owned and operated sewage works are financed from the general tax levies and, as a result, the funds available for their efficient operation are generally inadequate. This difficulty has been successfully overcome in some Ohio municipalities by making a charge for sewerage service to users of the sewers. Among the Ohio cities making charges for such service are Delaware, Oxford, Salem, and Dayton.

It is believed that, so far as practicable, the maintenance and operation of all sewage works as well as of tributary sewerage systems should be financed by funds collected from the persons or property owners benefited. The cost of construction of sewage works should, however, be borne by the entire communities benefited.

SUPERINTENDENTS NEED PRACTICAL EXPERIENCE

Superintendents of sewage works have been graded according to their education and experience. Three grades, A, B, and C, have been proposed with the following limitations:

Grade A. A graduate of an engineering or technical school of recognized standing, who has had experience for not less than five years in problems relating to sewage treatment. He should also be able to supervise and direct the work of others.

Grade B. At least a high school graduate with additional training in chemistry and engineering, who should have had experience for not less than five years in problems relating to sewage treatment. He should be able to supervise and direct the work of others.

Grade C. One who has had at least an elementary school education with training equivalent to that of a skilled mechanic or skilled laborer. He should be able to supervise and direct the work of others.

Grade A superintendents should be employed in large plants, serving approximately 100,000 or more people, where Imhoff tanks, sedimentation and sludge digestion, trickling filters, or the activated sludge process are used.

Grade B superintendents may be satisfactory for plants serving from approximately 50,000 to 100,000 people; but for the more complicated plants it is desirable to have the operation supervised by a sanitary engineer or chemist who has the qualifications of a Grade A superintendent.

Grade C superintendents may be satisfactory in the case of less complicated plants, such as fine screening, serving less than 50,000 people, providing there is adequate supervision by a sanitary engineer or chemist with the qualifications of a Grade B or Grade A superintendent. For small plants of a complicated type, or where difficult conditions must be met, a Grade B or a Grade A superintendent may be required. The practice followed by some communities of having a competent sanitary engineer to advise officials in regard to problems

of sewage works operation is a good one. This plan is especially desirable for a period immediately following the opening of a new sewage plant. Relative salaries, based on 1.0 as the wage equivalent for common labor, are suggested as follows: Grade A, 3.0 to 5.0; Grade B, 2.0 to 3.0; and Grade C, 1.0 to 2.0.

SCHOOLS FOR OPERATORS

Many operators of sewage works lack the basic training which is necessary to understand the fundamentals of sewage treatment and to supervise and operate, in a satisfactory manner, the plants they control. As a corrective measure there have been established in some States short-time schools, where instruction in the general principles of sewage treatment is given. It would be desirable to have at least one school for each State, except where the number of sewage works is small, in which case it may be feasible to organize a school for two or more adjacent States. The most important points to consider are the organizing and financing of the school, the character of the instruction to be given, and the payment of the students' expenses. It is recommended that the necessary expenses of sewage works operators attending schools or conferences be paid by the municipalities which employ them.

In general, State educational institutions which do extension work are the most desirable places to conduct the school. Where they do not exist, departments of health and sewage works associations are the logical organizations to establish and promote schools for sewage works operators. The general purpose of the courses should be to train students in the fundamentals of sewage treatment and in making laboratory tests.

In the instruction should be included lectures, laboratory work, and inspection trips. Lectures should deal with elementary sewage plant design, and the fundamentals of hydraulics, chemistry, and bacteriology. The scope of the laboratory work should vary with the length of the course and the previous training of the student. The most elementary course should include the keeping of records, the collection of samples, the measuring of settleable solids with Imhoff cones, the relative stability test, the determination of the pH value of sewage and sludge, and the operation of chlorine apparatus.

These studies may be supplemented, if time is available or if an advanced course is given, by practice in the use of the chemical balance, the determination of suspended solids, dissolved oxygen, bio-chemical oxygen demand, and the numbers of bacteria and B.coli. The length of the course would have to be limited to a short period—preferably not less than one week. A two-week session would possibly be the maximum length of time that could be devoted to this work.

Membership in sewage works associations affords another means of acquiring valuable knowledge relative to the operation of sewage treatment plants. A Federation of Sewage Works Associations has been formed, which publishes a *Sewage Works Journal*. This publication affords the sewage works operator an additional opportunity of familiarizing himself with problems relating to sewage treatment. Some State departments of health are responsible for calling conferences of sewage works operators in order to bring about an exchange of ideas regarding sewage treatment problems, and to promote economy and efficiency in the operation of sewage works within the State.

TESTS REQUIRED AT SEWAGE WORKS

There are three main objects of making analyses and tests at sewage treatment works: (1) for control of operation, (2) for record of accomplishment, (3) for research investigations.

The number and kind of analytical determinations and tests to be made will vary with the size and type of works. For small plants the routine tests may be confined to those required for the control of operation. For larger plants, especially where litigation may ensue, it is important to do more laboratory work than is required for the control of operation alone. Data should be obtained not only for studying the efficiency of the plant but also for comparison with similar data from other plants. At large sewage works, particularly where there are problems involving improvements or enlargements to the plant, or the recovery of by-products, research work should be carried on. Research in the treatment of sewage and industrial wastes is greatly needed, not only to promote economy and efficiency of treatment, but also to determine ways of recovering valuable by-products.

The analytical determinations and tests required for the control of operation and for a record of accomplishment may be classified according to the treatment provided, but some of the more widely used methods of sewage treatment will serve for illustrative purposes.

For the control of the operation of screens, the quantity of sewage screened and volume of screenings obtained should be determined. The time that the screens are in service, the work required on them, and their power consumption should be noted. For a record of accomplishment, the screenings should, where possible, be weighed, and the water content determined. The amount of solids removed from the sewage can then be computed. The efficiency of screening in removing suspended solids is accurately determined by adding to the weight of suspended solids determined in the screened effluent the weight of the dry solids in the screenings from a corresponding volume of sewage, and computing the percentage of solids removed by the screens. By determining the loss on ignition of the suspended solids in the effluent and of the solids in the screenings, the percentage removal of organic matter can be estimated in a similar manner.

A minimum requirement for the control of treatment by sedimentation should be the conical measuring-glass test for the volume of settleable solids in the influent and effluent. The quantity of sewage and the volume of accumulated sludge are also important factors in the control of the treatment.

For a record of accomplishment, the removal of suspended solids, by weight, should be ascertained by gravimetric determination of suspended solids in the influent and in the effluent. It is also important to determine the removal of organic matter. This may be done by determining the organic nitrogen or albuminoid nitrogen and oxygen consumed in the influent and the effluent. The reduction in bio-chemical oxygen demand has come to be considered an important index of the purification accomplished. Tests for dissolved oxygen in the influent

and the effluent should be made with sufficient frequency to show whether the sewage has become septic.

Relative stability tests of the effluent are desirable for the control of operation of trickling filters. The volumetric determination of settleable solids in the sewage applied and in the effluent is an index of the extent of the storage or unloading of solids in the filters. The volume of sewage treated by the filters and the condition of the filters with respect to clogging are also important factors in the control of operation.

For a record of accomplishment, the reduction in organic matter can be ascertained by determining the organic nitrogen or albuminoid nitrogen and oxygen consumed, or the bio-chemical oxygen demand in the influent and in the effluent. The extent of oxidation is further shown by reduction in free ammonia nitrogen and increase in nitrogen as nitrites and nitrates.

Where trickling filter effluents are passed through sedimentation tanks, the same determinations should be made of the tank effluent as have been recommended for the filter effluent. The suspended solids in the trickling filter effluent and the tank effluent should be determined gravimetrically. The dissolved oxygen in the effluent before and after sedimentation will indicate not only the degree of oxidation but also the effect of the sludge in the sedimentation tank.

For the control of the activated sludge treatment, the flow of sewage, the proportion of activated sludge returned to the sewage, the volume of air applied, and the amount of power used are important factors. The proportion of activated sludge present can be determined by sedimentation tests or more quickly by the centrifuge. A knowledge of the amount of solids in the sludge by weight is also important in the control of treatment. Tests for turbidity, suspended matter, and relative stability should be made on the effluent after sedimentation. The sludge level in the sedimentation tanks should be kept under control by measuring the depth of sludge in the tanks and by observing the character of the sludge withdrawn.

For a record of accomplishment, in addition to the above-mentioned tests, determinations of total nitrogen or of albuminoid nitrogen and oxygen consumed, or of bio-chemical oxygen demand should be made on the sewage and the effluent.

The extent of oxidation is indicated by determinations of free ammonia nitrogen and nitrogen as nitrates, and dissolved oxygen in the effluent.

Tests for the control of disinfection should be made for residual chlorine after an adequate period of contact. For a record of accomplishment, bacteria counts and B.coli tests should be made before and after disinfection. In some cases it will be desirable to determine the reduction in bio-chemical oxygen demand accomplished by disinfection.

For the control of sludge digestion, the appearance and odor of the sludge and the reaction, or pH index during digestion, are important. Temperature is also important, especially where control is exercised over it. For a record of accomplishment, the total solids and organic matter by loss on ignition should be determined in the raw and in the digested sludge in order to ascertain the proper volume to withdraw. Where gas is collected, it is desirable to obtain its volume and composition.

When sludge is dewatered on sludge beds, the volume of sludge applied, depth of application, time of drying, number of applications per year, weather conditions, and volume of dewatered sludge should be determined. Records of sludge-bed operation should include the percentage of solids in the sludge as applied and as removed.

Where sludge is dewatered by mechanical means, it is important to make tests of sludge density, solid content and reaction, or pH value, checked by rate-of-filtration tests in connection with the conditioning of the sludge for dewatering. The rate of dewatering by filtration of the sludge and the yield of cake are important. Determinations of the water and the solids in the dewatered sludge should also be made. When sludge is dried and prepared for fertilizer, the determination of its mechanical composition, percentage of moisture, and of the total and available nitrogen and other fertilizing constituents is important.

Where industrial wastes or sewage containing abnormal quantities of industrial wastes are treated, analytical determinations and tests in addition to those previously mentioned may be required, such as those for color, fats, alkalinity or acidity, iron, copper, lead, zinc, aluminum, calcium, magnesium, sulfates, and sulfides—depending on the kinds of industrial wastes present.

In many cases, especially where there is a possibility of litigation, tests should be made to determine the effect of the discharge of sewage or sewage effluent at different points on the receiving waters. These tests should ordinarily include color, dissolved oxygen and relative stability, or bio-chemical oxygen demand. The presence of sludge banks should be noted. In cases where the receiving waters are used for water supply, bathing, or shell-fish culture, bacteria counts and B.coli tests should be made. The time, extent, and frequency of such tests will depend upon local conditions. In certain instances, particularly in tidal waters and lakes, studies should be made of the currents where sewage effluents are discharged.

For comparative and analytical determinations and tests, it is of the utmost importance that the samples be truly representative. In order to obtain representative composite samples, individual samples should be taken at frequent intervals and in proportion to the sewage flow. Determinations of chlorine in the form of chlorides are of assistance in indicating to what extent samples are comparable.

In order to perform the necessary analytical determinations and tests, it is essential that suitably equipped laboratories should be provided. The larger plants will require complete equipment for making analytical determinations and tests needed for research investigations, as well as for a record of accomplishment. In the case of small plants, it may be sufficient to provide equipment only for the tests required to control the operation. Where local laboratories are not available, control samples should be collected at regular intervals and analyzed by the technical supervisor.

It is impossible to stipulate just what analytical determinations and tests should be made at every sewage treatment plant. Local conditions will often govern. The analytical determinations and tests suggested in this report may be considered generally applicable. Other determinations and tests will be required in special cases.

In all instances it is desirable to record the temperature of the sewage, effluents, and sludges in order to compare the results in different localities. Sufficiently complete analyses of the sewage should be made to determine its general character and composition.

KEEP COST DATA

Records of cost of operation and maintenance, in addition to other records already mentioned, should be kept at sewage treatment works. These costs should be segregated into labor and materials. Furthermore, it is desirable to keep operation and maintenance costs separate with a further record of the cost of all new additions or improvements. Should any money be collected from the sale of screenings, sludge, or other materials, the amounts should be recorded. At the large plants it is desirable to make a further segregation by keeping separate accounts of the cost of such items as screening, sedimentation, and sludge treatment. A record should be made of the sewage flow and the population served so that costs of treatment per unit volume of sewage and per capita can be calculated.

As improvements are made to the works from time to time and as old units are abandoned, the cost of these should be added to or deducted from the first cost of the plant so that the fixed cost, comprising the interest on the investment and depreciation, can be determined.

OPERATION REPORTS HELPFUL

In spite of the large number of sewage works of considerable size in this country, the number for which printed reports giving operating data are prepared is remarkably small. These reports are of much interest and value to all who are engaged in the design, construction, or operation of sewage works. It is mutually helpful for sewage works superintendents to exchange reports, and it is therefore highly desirable that printed reports be prepared, preferably annually, giving the operating and cost data, particularly in the case of works of any magnitude. The yearly budget, which provides for the cost of operation, should include an item covering the printing of an annual report. It is very desirable that articles relating to sewage works operation be published in engineering magazines or journals.

Respectfully submitted,

C. E. KEEFER, *Chairman*
W. R. COPELAND
A. L. FALES
J. A. VOGELSON
F. H. WARING

Need for More Operation Data Emphasized

IN THE wealth of discussion following the presentation of this report of the Committee on Sewage Works Operation and Control, all the important recommendations received repeated comment. So extensive is this material that it is impossible to give here more than the gist of the various remarks. This abstract therefore collects for the benefit of the busy reader the comments of the several discussers under their proper subject head.

Then, too, the general aspects of the report were analyzed. In commenting on these, Mr. Pearce stated that:

"Inasmuch as the usual handicap in sewage works operation is the lack of funds, the Division should support any move to provide increased funds for better operation. Those of us who are engaged in municipal work realize the demands made on the tax budget. Hence, time and the education of the public will be required to work out an adequate solution. The spread of the use of a service charge should help, but practical examples of results would be desirable. The enabling acts, cited by the Committee, all relate to Ohio. If the Committee could state how the laws have worked it would be worth while. Other States have enabling acts, such as Michigan's constitutional amendment, and the Sanitary District Law of Illinois. These permit the extension of rates or the creation of a utility.

"Financing has also been aided by the formation of sanitary districts. This plan has been particularly successful in Illinois. But even with such acts, the amount available for operation is frequently insufficient for the best service. The use of the metropolitan district scheme is also helpful. This has been taken advantage of in many localities not only in the United States but also in England, Canada, and Germany."

Attention was called by Dr. Hatfield to the satisfaction given by the 1917 Sanitary District Law of Illinois. It has two significant advantages in that it specifies an annual tax for the support of the district, which insures money for operation of the plant, and it divorces the control of the district from city politics by rotating the appointment of the trustees of the district. They are appointed by the county judge and serve for the low salary of $300 per annum.

PAYING RENT FOR SEWERS

Ohio's sewer rental laws have received considerable publicity, in the opinion of Dr. Mohlman, and it is now time that the engineering public received some information about their practical working. It would also be of interest to have more information on the bearing of such laws on a most troublesome problem in sewage treatment—industrial wastes. Do sewer rental laws offer a feasible method for the fair and proper apportionment of the cost of treatment of industrial wastes? It is obvious that volume of discharge may be only one of a number of factors in the determination of the cost of sewage treatment, yet the Dayton, Ohio, ordinances cited by the Committee reveal no differentiation between sanitary sewage and industrial wastes. Consideration of volume alone might be as unfair to certain industries as the use of sewage treatment facilities by other industries now seems unfair to the public. Therefore, a statement on the working of the Ohio laws with regard to industrial wastes would be of interest.

Dr. Hatfield concurred with Dr. Mohlman in his statement that rentals should consider not only the volume of water used, but also the concentration of the wastes delivered to the sewers. This is particularly true of industrial wastes that may be 10 to 100 times as strong as an equal volume of domestic sewage.

Increase in the cost of government will result from the

adoption of Ohio sewer rental laws where revenues therefrom are set aside and applied to a particular use, unless the general tax rate is reduced by an amount which balances the sewer rental assessment, according to Mr. Hoover. If the municipality could be required to set aside from the tax collection a predetermined sum for sewage disposal, as is done for the annual charges on the bonded debt, it might be simpler and less expensive to provide these funds from the general tax levies. A difficulty with this plan is the lack of interest in the matter. The sewage plant is so far removed from the city dweller and affects his daily life so remotely that he is concerned mainly with the adequacy of the sewerage system, if he is interested at all. Another difficulty to be overcome is the demand of various other groups for funds, such as those demanding extension of library facilities, recreational activities, or building inspection.

DR. MOHLMAN stated that the Dayton, Ohio, ordinance, cited in the Committee report, makes no distinction between sanitary sewage and industrial wastes. Consideration of volume alone might be as unfair to certain industries as the use of sewage treatment facilities by other industries now seems unfair to domestic users. In commenting on the Ohio sewer rental law, Dr. Hatfield said, "Rentals should consider not only the volume of water used, but also the concentration of the wastes delivered to the sewers. Industrial waste may be 10 to 100 times stronger than an equal volume of domestic sewage and its treatment correspondingly more expensive."

The experience of Mr. Hommon with the operation of the Ohio sewer rental law led him to feel that it works out very well; municipal authorities in the small villages where it is in operation are well pleased with the manner in which it functions. Mr. Hommon related an experience with a village board which passed a sewer rental ordinance only when it was realized that the passage of the ordinance would provide an annual income for the maintenance of the sewers without further action on the part of the board. The usual method of making annual appropriations from the general fund might result in neglect of the sewers by any subsequent, uninterested board.

QUALIFICATIONS NOT ALTOGETHER SATISFACTORY

Addition of a grade of sewage works superintendent between Grades A and B, as recommended by the Committee, was suggested by Mr. Calvert, who felt that the qualifications in the lower grades are insufficiently high. In the classification, as outlined, there seems to be no place for the Grade A superintendent to gain experience before taking full charge, except as an assistant. In suggesting compensation for the three grades, there would appear to be the danger of giving municipalities excuse for holding the rate of pay of particularly competent men at a figure lower than might be earned otherwise.

Partially trained men will, under the Committee's recommendations, have the necessary qualifications to operate sewage works in Class B cities with population between 50,000 and 100,000, where there may be complete sewage treatment plants costing from $500,000 to $1,000,000. It seemed to Dr. Hatfield that this is an undesirable situation and that both qualifications and salary scale require that Class A qualifications be demanded. Class B superintendents should be placed in cities of 25,000 to 50,000 population with, or contemplating, complete treatment. Cities below 25,000 population might get along with Class C superintendents provided there is adequate supervision by Class A men. There will naturally be many variations from the above arbitrary classification due to local conditions, but the cost and possible depreciation of sewage treatment structures justify in all cases the placing of men of higher training in charge of operation.

A LITTLE KNOWLEDGE IS DANGEROUS

Exchange of information through sewage works associations is of great value to Grade A and possibly Grade B superintendents, but Dr. Hatfield questioned the value of schools for sewage operators where an attempt is made to educate an untrained man in the rudiments of engineering, chemistry, and bacteriology. It can be done only in the most exceptional cases and it gives the operator and small city officials a feeling of false security. Such training and security should first come through the expert supervision of these smaller plants by Class A superintendents, and secondarily by State department schools.

In heartily approving the recommendation of schools for sewage works operators, Mr. Wheeler wanted the idea extended to include all sewage works employees, especially in the larger plants where the work is more specialized than common labor. Municipalities operating large plants and having a large labor turnover could profitably establish a school to acquaint their employees with the more specialized duties which will be encountered during the period of their employment.

RELATIVE VALUES OF TESTS

Recommended Laboratory Tests for Control of Sewage Plants

Treatment	Class A and B Plants Accomplishment*	Class C Plants Control
Sedimentation, primary or secondary	1. Suspended solids (Crouch) or	1. Settling solids in cones
	2. Weighed, settleable solids	
	3. Bio-chemical oxygen demand	
	4. Oxygen consumed as an indicator of bio-chemical oxygen demand	
Sludge digestion	1. pH	1. pH
	2. Carbon dioxide in gas	2. Temperature
	3. Methane in gas	3. Odor
	4. Alkalinity of liquor	
	5. Acidity of liquor	
	6. Per cent of solids (total and volatile)	
	7. Drainability	
Final treatment, filters or activated sludge	1. Bio-chemical oxygen demand	1. Stability
	2. Dissolved oxygen	2. Free ammonia
	3. Nitrates	3. Turbidity
	4. Total nitrogen	4. Settling solids
	5. Oxygen consumed	
	6. Free ammonia	
Chlorination at any point	1. Chlorine demands	1. Residual chlorine
	2. Bio-chemical oxygen demand	
	3. Hydrogen sulfide	

* Where necessary, total bacteria counts and B.coli indices should be run on the final effluent or on each individual process as the condition may demand.

To avoid unfruitful discussion of the relative value of certain tests, as recommended by the Committee, Dr. Hatfield suggested the foregoing tabulation to show the relative importance of the different tests for the control of sewage treatment plants.

NITROGEN AND CARBON TESTS QUESTIONABLE

Albuminoid nitrogen and oxygen consumed are so-called "proximate" analyses, the results of which may vary with the technic of analysis. The inclusion of these tests in the Committee's recommendations raised a doubt in the mind of Dr. Mohlman. He pointed out that it is possible, however, to determine total nitrogen, made up of the sum of organic and ammonia nitrogen plus, in the case of nitrified effluents, nitrite and nitrate nitrogen. This result is classed as ultimate or complete analysis and does not vary with the technic of determination. It would seem desirable, therefore, to eliminate the albuminoid nitrogen test and to recommend organic plus ammonia nitrogen determinations.

MECHANICAL HANDLING OF ONE-TON CHLORINE CONTAINERS

The sewage disposal plant, at Middletown, N.Y., uses modern method of closing effluent. Note glass covered sludge beds in right background

There is, as yet, no satisfactory, simple method for the determination of total carbon, but it is possible that such a method may be developed. The permanganate oxygen consumed is a very poor approximation and might well be eliminated from tests for plant control wherever organic and ammonia nitrogen and bio-chemical oxygen demand determinations can be made. As a measure of trickling filter efficiency, results of oxygen consumed tests are not of much value. The percentage reduction is usually much less than the percentage reduction of bio-chemical oxygen demand, which more truly expresses the degree of stabilization attained.

ALL SOLIDS NOT SETTLEABLE

The determination of settleable solids by weight, in addition to the Committee's proposed tests, was recommended by Mr. Enslow, who stated that this determination can be made by filtering a portion of the supernatant liquid from composite samples of crude sewage and tank effluent which have been allowed to settle in the laboratory. The difference between total suspended solids and the non-settleable suspended solids remaining in the supernatant liquid represents settleable solids. These figures are more valuable in determining settling tank efficiencies than any other item.

Since settling tanks can remove only settleable solids, the evaluation of performance on total suspended solids is not a fair index. Records indicating low settling tank efficiencies, when judged by suspended solids removed, might be shown on tanks functioning as efficiently as 98 per cent. Calculations made on the basis of the maximum possible solids removed by quiescent settling of samples of crude sewage for the number of minutes representing the period of detention available in plant operation, gives a fair means of determining tank efficiencies.

In connection with trickling filter performance, Dr. Hatfield stated that it is not clear why the volumetric determination of solids in the applied settled sewage and discharged effluent should prove particularly valuable. If anything, the suspended solids by weight in the applied and in the discharged sewage should prove of considerably greater value. The Committee recommends the gravimetric determination on filter discharge and secondary tank effluent, and it should likewise be made on the settled sewage applied.

The recommendation was made by the Committee that influents and effluents of sedimentation units should be sampled to determine the removal of suspended solids. As this introduced an error, it was suggested by Mr. Calvert that the same method of computation be used as is used for the determination of screenings removed. He stated that it is recognized that in some plants it is impossible to measure the solids actually settled, and in such cases the use of extremely large samples should be encouraged with a measurement of the larger particles separately from the smaller ones.

OXYGEN INDICES IN SEDIMENTATION AND FILTRATION

Reductions of oxygen consumed and oxygen demand are the best available indices for determining the percentage of purification accomplished through settling tanks, as stated by Dr. Hatfield. However, the true value of settling is not shown because the reduction of the oxygen demand is not revealed by five-day incubation periods, whereas the oxygen demand of settled sewage given five days incubation is more nearly the whole of the demand than is the case with crude sewage. Second to oxygen demand reduction, the removal of suspended solids is the best index.

Loss of dissolved oxygen during the passage of filter effluents through secondary tanks, the loss of nitrate nitrogen, and change in the oxygen demand value have been found by Dr. Hatfield to be valuable indices of the relative efficiencies of these units. In summer, the loss of nitrates and increased oxygen demand will indicate the condition of the secondary tanks as shown by actual observations disclosing at times deficiencies rather than efficiencies.

RIDEAL-STEWART METHOD OBLIGATORY

In trickling filter treatment of sewage, reference to albuminoid nitrogen and oxygen consumed tests might be eliminated, according to Dr. Mohlman, since this report is a summary of recommended procedure with the selection of only the most desirable tests. A word of caution should be given on the determination of dissolved

oxygen in trickling filter effluents containing large amounts of nitrates. The Rideal-Stewart modification (acid, permanganate, oxalate) must be used, or the results will be fictitious and far too high.

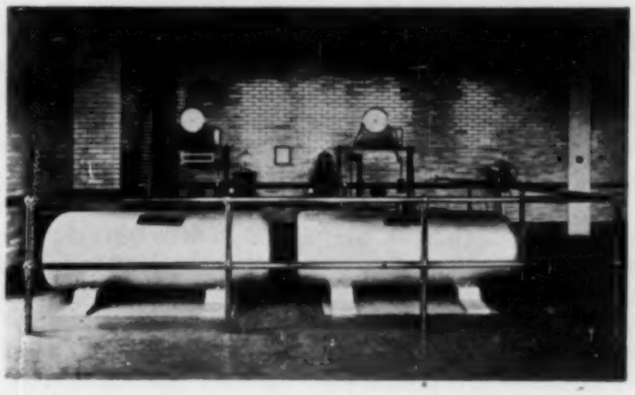
TESTS ON ACTIVATED SLUDGE ARE DIFFICULT

According to Dr. Mohlman, tests for the proportion of activated sludge in the aeration tanks can easily be made by settling in cylinders or by the use of a centrifuge; but the results do not mean much when the sludge bulks, or when one plant is compared with another. Determination of the weight in parts per million of suspended solids (sludge) in the aeration tanks is preferable, or should be made in addition to the settling tests. Tests of turbidity of activated sludge are misleading, because the suspended solids are usually not present as a colloidal suspension, but rather as a light floc, which settles after standing, leaving a fairly clear, supernatant liquor. The relatively large floc cannot well be measured by turbidity determinations, but should be determined as suspended solids. Turbidity results on activated sludge effluents are likewise misleading and do not indicate the degree of clarity or freedom from suspended matter. Albuminoid nitrogen and oxygen consumed are also recommended by the Committee for tests on activated sludge effluents. Efficiencies based on these tests are low and bear little relation to the actual stabilization of the sewage, as best indicated by the bio-chemical oxygen demand test.

The value of the determination of the dissolved oxygen in the effluent of an activated sludge plant was questioned by Mr. Hoover, who felt that it may not show properly the extent of oxidation. He also suggested that the statement relating to the determination of oxygen demand in a disinfected effluent should have carried a word of warning that this determination on a disinfected effluent is not as simple as it sounds. Operators should not lose sight of the fact that the amount of volatile material determined in many sludges and sewages is affected by the considerable weight of carbon dioxide driven off from the normal carbonates in the residues.

It seemed to Mr. Calvert that the organic or volatile solids in an activated sludge are more important than the actual weight of sludge solids. This does not mean that activated sludge may be rated on the basis of organic content, since often the volatile solids may be quite high with the sludge ineffective as an agent in sewage treatment. No laboratory determination has been devised as yet to express a measure of the value of activated sludge as a purifying agent.

Instead of the term "disinfection," Mr. Enslow recommended the use of the word "chlorination." In recommending the making of B.coli tests, Dr. Mohlman presumed that the Committee intends to state that only presumptive tests be made, as there is little reason for confirmation except under special conditions.



Chlorine Installation Using One-Ton Containers

An ideal arrangement of duplicate installation for the treatment of sewage effluent

INSUFFICIENT DATA ON SLUDGE DIGESTION

Need for the determination of the moisture content of sludge at various depths in the digestion tank was felt by Dr. Mohlman. At the Calumet Works of the Sanitary District of Chicago such tests are made monthly in the Imhoff digestion chambers at 3-ft. differences in depths. Such data are invaluable for computations of required digestion capacity. A most important factor in design is the moisture content of the sludge. Usually this is estimated on the basis of very little actual information. The Committee should strongly urge the accumulation of more data on this subject.

In addition, he suggested that the determination of volatile matter in dried, activated sludge be recommended in order to compare and explain the nitrogen content of various activated sludges. Where activated sludge is disposed of by digestion and drying, tests of nitrogen and of phosphorus in the dried sludge as well as its moisture content should be made periodically in order to show what value the sludge may have locally as a fertilizer.

One of the important elements in comparing the behavior and loading of sewage treatment works is the extent of industrial waste entering the sewage. Mr. Pearse suggested that the determination of the population equivalent for the industrial waste be made, and a survey of the wastes should be included in the routine of the sewage works operation. The frequency of sudden rushes of troublesome waste should also be noted. Mr. Calvert thought that it would be well to include a determination of carbohydrates and organic acids or salts in sewage containing industrial wastes.

At Decatur, Ill., periodic surveys of the Sangamon River are made by Dr. Hatfield, and the relative order of importance of the tests is: (1) B.coli index, (2) total bacteria count on agar at 37 deg. cent., (3) dissolved oxygen, (4) bio-chemical oxygen demand, (5) temperature, and (6) stage of river. In most instances, however, the dissolved oxygen and the bio-chemical oxygen demand should rank before bacterial counts. Mr. Hoover suggested also the inclusion of a temperature test. Mr. Pearse desired to add a determination of suspended matter in the effluent from the treatment plant, but he felt that a determination of relative stability is not reliable as a measure of the polluting power of the effluent.

AUTOMATIC SAMPLERS ADVANTAGEOUS

The recommendations that samples be taken at frequent intervals should state specifically at what intervals, as was suggested by Dr. Mohlman. He stated that for small plants it is rarely feasible to take even hourly

samples for a 24-hr. composite, and it is even more difficult to get samples in proportion to the rate of flow. It will be extremely difficult, if not impossible, to determine population equivalent, effect of industrial wastes, or even to interpret the analysis from a 24-hr. sample or a composite made up of three 8-hr. samples.

In the opinion of Mr. Pearse, the need for proper sampling has been insufficiently emphasized. He suggested the use of automatic samplers to overcome the difficulties of hourly sampling at small plants. The experience of Mr. Goodman with automatic samplers has convinced him that automatic samplers which take a small sample at frequent intervals are superior to any manual sampling method.

COST DATA DIFFICULT TO ANALYZE

In most plants it is quite difficult to separate maintenance and operation costs since the dividing line between the maintenance of permanent equipment and their ordinary upkeep is narrow, in the opinion of Mr. Calvert and Mr. Hoover. Mr. Calvert stated that to obtain unit costs, the cost of new equipment as purchased should be added to the capital charge with suitable interest, and the depreciation allowance charged into the total. It would appear that interest and depreciation should be included in unit costs until the equipment is paid for, regardless of obsolescence.

Considerable confusion now exists because the methods used in arriving at unit figures in activated sludge plants are not explained. For example, the quantity of air per gallon may be based either on the quantity of raw sewage handled or the quantity of mixed liquor put through the aerator. In the settling tanks, the detention period or the rate per square foot may be confused on the same account. Some uniform method should be adopted or the operators should be urged to state fully the conditions on which the figures are based.

Operating records should be kept to show, as far as possible, the number of men employed and their respective degree of skill or trade, as well as their assignment, in accordance with the suggestions of Mr. Pearse. Such records should show yearly averages and seasonal variations, such as sludge stripping or loading. As rates of pay vary throughout the United States the basic data, such as might be styled budgetary, are more useful than merely totals of costs in dollars. The grouping of the cost of supplies and repairs on different parts of the works, as well as data on depreciation, will also be of value.

A Committee of the Federated Sewage Works Associations is working on the problem of developing a standard method for computing sewage works costs, according to Mr. Goodman. He, therefore, suggested that the studies of the various committees be coordinated.

DAYTON ORDINANCE UNFAIR

The Dayton ordinance quoted by the Committee seemed unfair to Mr. Calvert, as the outlined scheduled rates place the greatest burden on the householder and the small user of water. It would appear that there should be no greater charge per 1,000 cu. ft. of waste from the householder than from the industries, other than the slight additional cost of collection of small bills. It is perfectly true that additional quantities of sewage above a certain minimum can be treated at a decreased unit cost, but the advantage of increased quantities to the sewage plant are less than in the case of a water works.

Industrial wastes are generally very much stronger than domestic sewage, and the organic material contained in them is harder to treat. It would seem fair and equitable to charge the utility on the basis of weight of oxygen demand with a sliding scale for various types of wastes. This is a development which will be possible only after extensive study and experimentation.

HYDROGEN SULFIDE MEASURES SEPTICIZATION

Hydrogen sulfide determination is crude, and settled sewage is suggested by Mr. Enslow for the study of sedimentation. The development of a colorimetric method, as described in the *California Sewage Works Journal*, 1929, renders this determination short and simple, and it is of particular value in the field. This test can also be used to determine the rate of septicization along a sewer and through settling tanks.

Omission of the question of residual dilution was found strange by Mr. Pearse. The importance of this factor in sewage disposal is appreciated when it is realized that sewage treatment is not a 100 per cent purification. The conclusion is reached that at present the basic control of sewage works should be largely limited to determinations of the bio-chemical oxygen demand, dissolved oxygen, and ammonia; organic, nitrate, and nitrite nitrogen; and suspended solids. Other determinations may be required for special conditions, but the quality of the effluent may be controlled and demonstrated by these tests. Such tests should also be extended to the receiving waters, and the respective volumes of effluent and receiving water noted, as well as the opportunity for re-aeration in subsequent flow.

A record should be kept of the residual dilution and the condition of the stream or body of receiving water below the points of discharge throughout the year.

RECOMMENDATIONS SHOULD BE SPECIFIC

Discussion of the general value of the Committee's recommendations inclined toward the viewpoint that the recommendations are insufficiently specific. In this connection Mr. Calvert summarized his views by remarking: "The lack of detailed specifications and recommendations is unfortunate, perhaps, but it is recognized that it is impossible to put down hard and fast conditions for the operation of sewage plants and the expression of results."

Dr. Mohlman questioned whether an actual outline of control tests required, with specific reference to methods of analysis, form, and frequency of reports, and instructions for sampling, might not be more valuable than such a general descriptive statement as that made by the Committee.

Good operators of small plants are usually eager to use whatever control tests are practical for their conditions. Specific recommendations would be followed.

With the growth of State sewage laboratories, mobile laboratories and sewage works associations, and the licensing of sewage works operators, there is hope in the next decade of a great improvement in the efficiency of operation of sewage treatment works.

Loading Six Million Tons of Coal

New York Central Has Remarkable Coal Dock and Car Dumper Plant at Toledo, Ohio

By J. A. Stocker

Chief Engineer of the Ohio Central Lines of the New York Central Railroad Company

DESCRIPTION of this large coal-handling equipment was a particularly fitting subject for the Cleveland Convention inasmuch as Cleveland is the center of a great coal shipping region. A number of plants resembling the New York Central's Toledo dock, here described, are located on Lake Erie so that these articles will give to those far removed from the region an insight into this great industry. Thirty-three million tons annually pass through Lake Erie ports during the eight months' shipping season. In this highly competitive business, speed and quantity of coal handled determine where the business goes. How the New York Central Lines solved the many complex engineering problems involved in efficiently handling their share of the Lake coal movement at the Toledo Plant, is interestingly described in these papers, which were presented before the Waterways Division of the Society at the Cleveland Convention in July 1930.

A LARGE tonnage of coal, transported by combined rail and water haul from the mining fields to its destination, passes through Lake Erie ports. It is transferred from cars to boats on the coal docks at Toledo, Sandusky, Huron, Lorain, Cleveland, Fairport, Ashtabula, and Conneaut, in Ohio; and Erie, Pa., for transportation to other ports on the Great Lakes. The principal receiving ports are Superior, Wis., and Duluth, Minn., on Lake Superior; and Green Bay and Milwaukee, Wis., Chicago and South Chicago, Ill., and Indiana Harbor and Gary, Ind., on Lake Michigan. At these ports, and others, the coal is unloaded for local use or for further transportation by rail.

The average tonnage handled per year, during the 19-year period, 1911 to 1929 inclusive, was 27,113,767. The average, during the first 5 years of this period, was 22,531,669; and during the last 5 years, 33,220,928, an increase of 47 per cent.

LAKE COAL HAS MANY GRADES

Coal transported by this means is known as "Lake" coal, and its transfer from cars to vessels at Lake Erie ports is an operation of great importance to the transportation lines involved and to the shippers. Many shippers of Lake coal handle several kinds, each being known as a "grade" or "consignment" and given a name. For example, John Smith may deal in Pocahontas Lump, to which he assigns the name "Corrigan," and Pocahontas Slack, to which he assigns the name "Murphy;" while John Jones may handle Pocahontas Lump from the same territory under the name "Siwash," and Pocahontas Slack under the name "Apache." Thus, there are actually two kinds of coal, but four grades. This results in a very large number of grades of Lake coal. During 1929, there were 296 active grades of Lake coal involved in the operation of the New York Central dock, at Toledo. The maximum number of grades carried in the dockyard on any day was 110; the lowest number was 7; and the average throughout the Lake season was 83. It is apparent that the classification and storage of Lake coal under these conditions is complicated and involves an operation far different from that of the ordinary classification and storage yard.

As each train of coal arrives at the dockyard it must be switched so that all coal of a certain class is grouped together, and each class must be stored separately so that it is readily available for placing at the dock when required for loading. Boats are assigned by the Ore and Coal Exchange, a railroad organization with an office in Cleveland, acting as the representative of the railroad companies in dealing with the water transportation companies and the shippers. In general, the superintendent of a coal dock receives about 24 hours advance notice of the arrival of a boat at that dock for loading.

In issuing such notice the Ore and Coal Exchange furnishes a statement covering the grade or grades, and the amount of each required for each compartment of the boat. The dock superintendent and the yardmaster thereupon cooperate to the end that the proper amount of coal of each grade is spotted in the load yard at the car dumper when the boat arrives at the dock. Occasionally, one boat will pass another after the advance notice has been issued, or the cargo may be changed after the boat arrives at the dock, and coal spotted in the load yard may have to be removed and other coal substituted to meet the new requirements.

Lake coal business is highly competitive, delays are expensive, and supplying coal to the car dumpers to meet all the varying conditions requires flexible and extensive yard facilities, and the most careful attention of all those concerned in this operation.

The two car dumpers on the New York Central dock at Toledo handled 6,698,380 tons of coal during 1929. A total of 116,604 cars was dumped, the average load per car being 57.4 tons. The total number of boats loaded was 1,100; the average number of cars loaded per boat was 106; the average tonnage of coal loaded per boat was 6,089.

For the entire 1,100 boats the average number of grades of coal loaded was 2.83 per boat. These grades are generally kept separate in the boat, either by loading an entire compartment with one grade, or by dumping one grade on top of another. Occasionally, the shipper desires the coal mixed, and alternate cars of different grades are dumped into the same compartment. The grades are kept separate in the load yard of the dumper,

PANORAMA OF LOADING DOCKS AND CAR DUMPERS

and the cars are fed to the dumper from one track or another as may be required to supply the desired grade.

CAR DUMPERS LOAD BOATS

At Lake Erie ports the process of loading coal into boats differs greatly from that at Atlantic ports. Coal boats on the Great Lakes have hatches nearly the full width of the boat, extending from one end of the cargo compartments to the other, so that coal can be deposited in any part of a compartment with a minimum amount of trimming. Sea-going boats have smaller and fewer hatches, requiring horizontal distribution of the coal into the cargo space.

On the seaboard the boat is either docked in a fixed location, the loading chute being moved from hatch to hatch to accommodate the boat, or it is shifted backward and forward at the dock by means of dock winches handled by the dock employees. At Lake Erie ports the boat is moved backward and forward in front of the car dumper by the boat winches, handled by boat employees. In loading sea-going vessels, breakage of coal by the trimming apparatus is unavoidable, while on the Great Lakes the breakage of coal in transfer from car to boat must be held to a minimum. This is accomplished by controlling the flow of coal into the boat and placing it with the least amount of trimming. Table I gives typical examples of the process of loading Lake boats, based on observations taken at the New York Central dock at Toledo.

TABLE I. BOAT LOADING STATISTICS

ITEMS	BOAT NUMBER			
	1	2	3	4
Number of cars dumped	178	147	116	211
Number of times boat was shifted while loading	24	25	25	22
Average number of cars dumped between shifts	7.4	5.9	4.6	9.6
Total time consumed in shifting, in minutes and seconds	58-02	41-18	42-11	64-13

Under favorable conditions the car dumper at the Toledo dock will handle a car of coal a minute, but ordinarily it will require five to six hours to load a boat of from 8,000 to 10,000 tons capacity.

LOADING DOCK AT TOLEDO

The New York Central dock, at Toledo, is on the east bank of the Maumee River. It has a pile and concrete bulkhead, about 4,000 ft. long, near the harbor line, with the top elevation 7 ft. above mean lake level. The entire area between the bulkhead and the Government Channel, with an average width of 200 ft., is dredged to 22 ft. below mean lake level. The Government Channel is 400 ft. wide. There is, therefore, an average width of 600 ft. of deep water in front of the bulkhead throughout its entire length, and boats can arrive at and depart from the dock under their own power and without the use of tugs. One car dumper is located 800 ft. from the north end of the bulkhead and the other 1,400 ft. farther south. Boats tied up at the dock can move to either car dumper, as may be required, under their own power.

Immediately back of the car dumpers is a Lake coal storage yard with a capacity of 900 cars. Between the dock and the Toledo Terminal Railroad crossing, about 3 miles distant, there is a Lake coal storage yard with a capacity of 2,900 cars. South of the Toledo Terminal Railroad, about 5 miles from the dock, is a classification yard for Lake coal, local Toledo business, and interchange with other railroads, with a capacity of 4,500 cars. Two running tracks, connecting the dock with the storage and classification yards, provide for the free movement of cars to and from the dock.

REQUIREMENTS OF DESIGN

Both dumpers are of modern design, one having been placed in service in the spring of 1926, and the other in the spring of 1929. In their design careful consideration was given to meet the requirements outlined below.

Safe, speedy, and reliable operation is essential, for the Lake coal season extends over only eight months of the year. Lake boats must spend as little time as possible at the dock receiving or discharging cargo, and shippers and boat owners naturally favor the dock with the best record for prompt and speedy loading. Its operation must be protected with safety devices to insure against delays and accidents.

As the shipper is vitally interested in the prevention of degradation of the coarser grades of coal in transportation from the mines to the consignee, there must be a minimum of breakage in the process of dumping. A car dumper must be designed to transfer the coal from the car to the boat with the least possible breakage.

Because of the wide variation in the size and capacity of cars commonly used in the transportation of coal, it is necessary that the dumper handle cars with a wide range of sizes and capacities. Any class of coal-car equipment may be received at the dock.

There is a wide range in the size of Lake boats and, in general, they fill their fuel bunkers at the same dumper at which they receive their cargo. Ordinarily, the

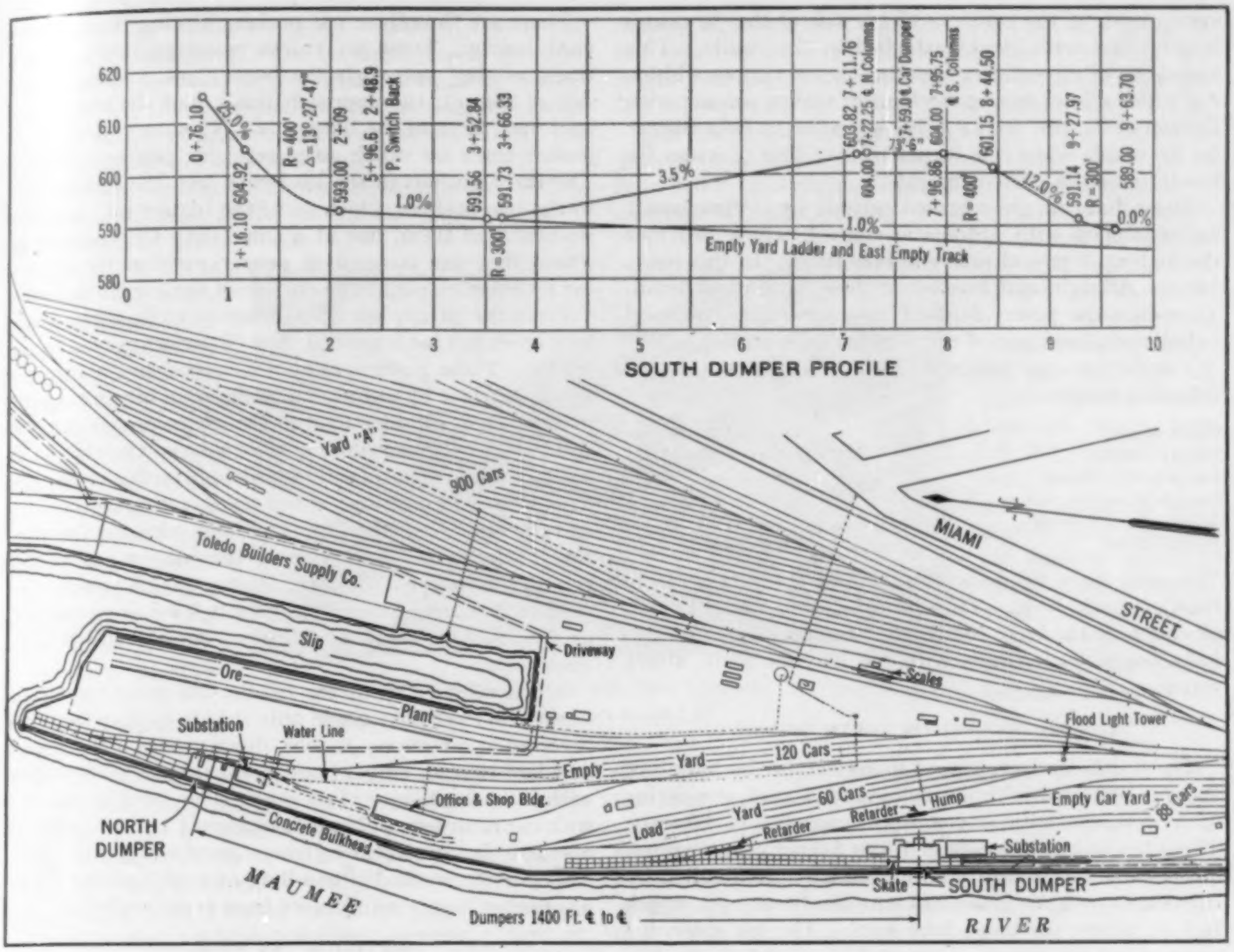


FIG. 1. YARD AND TRACK LAYOUT

hatches of the fuel bunkers are at a considerable height above the cargo hatches, and are smaller and difficult of access. Coal, therefore, must be deposited in the boat throughout a considerable range of heights and distances from the face of the dock, and the dumper must be designed to meet these requirements, with the flow of the coal under complete control at all times.

Minimum loss of time in changing from hatch to hatch is also important since the boats are moved frequently during the process of loading, and it is necessary that the dumper be designed so that it can clear the boat quickly to permit shifting. The four boats loaded at Toledo, as described in Table I, were each shifted an average of 24 times during loading, and the time consumed while shifting was one-fifth that consumed in dumping coal.

Proper grades of coal must be available at all times in required amounts. To keep the grades of coal separate, to load the desired amount into each compartment and through each hatch, and to load the fuel bunkers of the boat at the proper time, great flexibility of operation is required. Frequently, a portion of a carload is poured through one hatch and the remainder through another after the boat has been shifted.

OPERATING CHARACTERISTICS

The two dumpers at Toledo, built by the New York Central Railroad Company to meet these requirements, have the following general characteristics.

They are of the elevating turnover type. Loaded cars are placed on a cradle, which is elevated to the desired height and rotated about a horizontal hinge, turning the car over so that the coal flows onto a tapered, inclined pan, or apron, with the higher, broad end next to the dumper and the lower, narrow end over the boat. A swinging telescopic chute attached to the lower end of the pan conveys the coal into the boat.

The elevation of the hinge, the elevation of the pan, the inclination of the pan, and the length and direction of the chute, are adjustable. In operation, the lower end of the pan and the chute are kept full of coal as much of the time as possible, and the coal is permitted to flow from the lower end of the chute in a steady stream at slow velocity. There is, consequently, a minimum breakage of the coal. One car is dumped at a time. The car can be stopped in any position, so that all or part of the carload may be delivered to the boat as required.

The cradle is provided with a movable platen, consisting of a pair of track rails on a girder span. The track rails line up with the approach and run-off tracks when a car is being delivered to the dumper. As the cradle begins to rise, the platen moves laterally toward the

vertical side of the cradle until the side of the car comes into contact with blocks attached to the cradle. This arrangement provides for handling cars of various widths. An adjustable clamping mechanism makes contact with the top of the car, as it is being elevated, to hold the car on the cradle when it is turned over. This provides for handling cars of various heights.

These dumpers are operated entirely by electric power and equipped with automatic control, which provides the highest degree of safety in operation. In this issue, Messrs. Albright and Rice cover these features in detail. To reduce the power demand, counterweights are used to balance a large part of the total load elevated.

The dumpers are designed to handle all cars within the following ranges:

Gross weight	90,000 to 330,000 lb.
Empty weight	30,000 to 90,000 lb.
Length of car inside	26 to 56 ft.
Length of car over-all	28 to $58^1/_2$ ft.
Width of car over-all	$8^1/_2$ to 11 ft.
Height of car	$6^1/_2$ to 13 ft.

The clear space between front posts for rotation of the cradle is 64 ft. wide. These dumpers will load all types of vessels in the Lake coal trade, ranging from barges to Lake boats, 64 ft. wide, with the hatches 35 ft. above water.

CAR RIDERS USED ON NORTH DUMPER

The north dumper, placed in service in the spring of 1926, is provided with an inclined load yard, consisting of five tracks with a combined capacity of 60 cars. These tracks have a grade of 1.5 to 2.0 per cent descending toward the dumper, and loaded cars are handled by car riders down the grade and onto the barney pit, which is 7 ft. above the mean lake level. The car rider dismounts and the barney, connected by a cable to an electric hoist in the lower part of the dumper, pushes the car up a 12 per cent grade onto the cradle, which is 26 ft. higher than the barney pit. The barney is of the disappearing type, and a car can be "spotted" on the barney pit while the barney is pushing another car up the grade. On its return trip, the barney passes under the car on the pit and comes up in the rear of it.

Reaching the cradle, the loaded car bumps the empty off and is stopped in place by a retarder operated by compressed air, under the control of the operator who runs the barney. The empty car, controlled by a car rider, runs down a 7 per cent grade onto a kick-back, which reverses its direction; thence, down grades ranging from 2.2 per cent to 0.0 per cent into an empty yard consisting of five tracks with a total capacity of 120 cars.

During the four years, 1926 to 1929 inclusive, this dumper handled 17,235,450 tons of coal. In 1928, it handled 5,202,087 tons.

ELECTRIC CAR PUSHERS OPERATE SOUTH DUMPER

The south dumper, which was placed in service in the spring of 1929, operates without the use of car riders. It is provided with a level load yard, consisting of six tracks with a total capacity of 144 cars. The spacing of these tracks is alternately 16 ft. and 13 ft., center to center. In each of the 16-ft. spaces, there is a 36-in. gage track between the standard gage tracks for the operation of an electric car pusher to serve the track on either side of it.

There are thus three car pushers serving the six load-yard tracks. These six tracks converge into a single track as they approach the barney pit. Along either side of the pit, the approach track, and the end of the load yard next to the barney pit, is another 36-in. gage pusher track on which an electric car pusher operates. The three pushers in the load yard feed the cars in cuts to the two pushers, which serve the barney pit; and the pushers feed them, one at a time, onto the barney pit, where they are stopped in proper position by a fixed car retarder, engaging the outside of the car wheels only.

From the barney pit whose track is 16 ft. above mean lake level, the car is pushed up a 12 per cent grade to the cradle. These pushers are not attached to the car, but simply move it by means of a pusher arm bearing against its rear sill. In order to stop the car in proper position and prevent it from running part way up the grade and rolling backward, a retarder is provided on the barney pit. This is fixed in position; it has no operating mechanism, and the car is pushed out of it without releasing the pressure. Mechanical operation of the barney and of the retarder is covered by Mr. Brown in his paper. Ingenious measures for electrical control are also provided, as described in detail by Messrs. Albright and Rice in their paper.

When released from the cradle, the empty car runs down a 3.5 per cent grade onto a kick-back, where it is reversed in direction; thence, down grades of 1 per cent and less into an empty yard consisting of seven tracks with a total capacity of 88 cars. This yard is provided with car retarders and switch machines, controlled by an operator in an elevated tower overlooking the yard. This gravity method of handling cars without car driver has proved highly satisfactory from every angle.

THIRTY-TON CAR PUSHERS

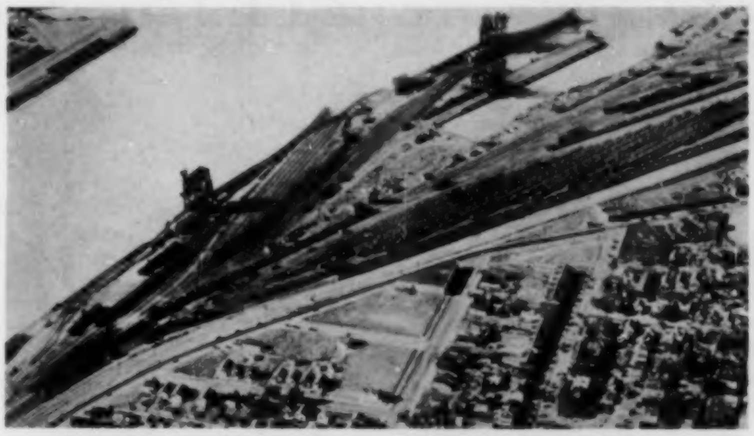
The electric car pushers are of the traction type with four wheels. They are especially designed to push cars on adjacent tracks by means of a manually operated pusher arm, or bar, which moves laterally through the body of the pusher and is located so that it can be extended into the space between the cars and make contact with the end sill at an elevation from 35 to 46 in. above the rail. The pusher arms are equipped with flat leaf springs, which permit the end of the arm in contact with the car to deflect slightly in absorbing the impact when engaging the car.

Each pusher is equipped with two 125-hp., totally enclosed, split-frame, railway-type series motors, with axle brackets and suspension lugs on the lower frame. Armatures are carried on roller bearings in separate frame heads clamped between motor frames. Each motor is spring-suspended from the pusher frame and drives an axle through a single reduction spur gearing 4.62 to 1, totally enclosed. All resisters are of the alloy-steel, edgewise-wound type. Each pusher is equipped with two over-running collector shoes beneath the frame, making contact on two collector rails between the track rails and under a creosoted plank walk in the middle of the track, which protects them from accidental contact by employees.

Electrical control is of the magnetic type, using contactors arranged for series-parallel operation, employing six points of series and five points parallel, starting in

series only. Reversing levers are interlocked with the drum of the controllers. The reversing levers must be in forward or reverse position before the pusher can be operated. Overload protection for traction motors is provided by relays and railway-type ribbon fuses. All auxiliary circuits are separately fused.

Pushers are equipped with a straight airbrake, with a 25 cu. ft. per min., motor-driven air compressor. A hand brake is also provided. The brake rigging is hung inside and is provided with American Railway Association shoes and heads. Track sanders, operated by air, are controlled from a fully enclosed cabin at one end, which contains all control and protective apparatus. The windows are arranged so that the vision of the operator is obstructed as little as possible. Doors fold back against the inside, and are left open while the pusher is in operation. Headlights are provided, both front and rear, and a side light on either side to illuminate the pusher bar and the cars.



AERIAL VIEW OF THE TWO DUMPERS
South Dumper at the Left

General specifications for these pushers are as follows: weight, 30 tons; rated tractive effort, 15,000 lb.; maximum tractive effort, based on 30 per cent adhesion, 18,000 lb.; rated voltage, 250 direct current; speed at rated tractive effort and voltage, 4 miles per hr.; speed, running light, on level track, 12 miles per hr.; gage, 36 in.; wheel base, 10 ft.; diameter of drive wheels, 38 in.; length over-all, 24 ft. 6 in.; width over-all (with pusher arm withdrawn), 4 ft. 10 in.; and height over-all, 8 ft. 7 in.

The conductor system consists of two 80-lb. rails, spaced $11^1/_2$ in. between the track rails. They have third-rail type porcelain insulators $2^1/_2$ in. high, approximately 5 ft. apart, resting on the track ties. Each rail joint has two 0000 gas-weld bonds and, in addition, the joints of the two sections of the system, carrying the load for all pushers, are each bonded with one 500,000 cir. mils gas-weld bond. The conductor rails are completely insulated, and the polarity of rails is identical for all tracks. Power for the conductor rail system is brought from a special switchboard panel in the substation over two 1,000,000 cir. mils, 600-volt, lead-covered cables in creosoted-wood trunking, installed at ground level. Disconnecting and throw-over switches, air-circuit breaker, voltmeter, and ammeter are mounted on the switchboard. One 375-kw. generator unit is provided in the substation to furnish current for the pusher operation and, in case of failure of this unit, power can be taken from one of several other units.

Electrical Operation of Car Dumper

By C. S. ALBRIGHT and R. E. RICE
ELECTRICAL ENGINEERS, NEW YORK CENTRAL RAILROAD COMPANY

THE operation of the dumper proper consists of six distinct movements, those of the barney and cradle being the two principal ones. The barney pushes the car of coal up the incline track from the load yard to the cradle of the dumper, thereby gaining about 15 ft. in elevation. The cradle or hoist engine, which is a vertical hoist, elevates the car to a height of 12 to 24 ft., as required, and then turns it over, dumping the coal into a pan. These and other mechanical details of the dumper are described by Mr. Brown.

The various movements are controlled from three locations on the dumper. The barney movement is controlled from the cabin, called the barney operator's cabin, on the back side and on the approach end of the dumper, about 10 ft. above the level of the platen. This operator also controls the car retarder on the platen and likewise starts the cradle to hoist. In a second cabin, called the cradle operator's cabin, located on the front column at the approach end of the dumper, about 40 ft. above the platen, are master controllers for the operation of the cradle and pan, with transfer switches to give the operation of the cradle and pan to the operator located in a cabin called the chute operator's cabin, at the front end of the pan. In this cabin are master controllers for the operation of the cradle, pan, screw girder, chute, and trimmer. Under normal conditions these operations are all controlled from this cabin.

The cycle of operation is as follows. The loaded car of coal is placed or spotted over the barney pit at the foot of the incline, on the approach track to the dumper. The operator starts the barney out of the pit at full speed. As it approaches the car, it automatically decelerates to a slow speed, engages the car, and automatically accelerates it to full speed, bringing it up the incline. As the car nears the cradle, the barney operator slows it down to a speed suitable for bumping the empty car off the cradle. The loaded car is stopped by the operator at the proper location on the cradle by the car retarder on the

platen. The barney controller is thrown to "lower" and the barney automatically returns to the barney pit ready for the next car.

As soon as the car is stopped, the cradle operator pushes a "start" button and the cradle automatically hoists, dumps, and returns the car, provided the chute operator has the master controller for the cradle operation in the hoist position. The cradle automatically accelerates to full speed, slows down to engage the hinge, accelerates to turn, turns automatically, decelerates, and stops with the car in the dumping position, where the car remains long enough to empty its coal into the pan.

The lapse of time at this point is about 2 or 3 sec., but is adjustable to a longer time if necessary. At the end of the elapsed time, the cradle automatically accelerates downward, slows up to engage the front columns, accelerates to full speed, slows down, and automatically decelerates to a stop with the cradle in the seated position ready to receive the next loaded car.

ELECTRIC CAR PUSHER SPOTTING CAR OVER BARNEY PIT
Barney-Pit Car Retarders in the Foreground

In order to gain a maximum of flexibility, Ward Leonard control is used in the main drives. Its most important features include the armature circuit between the hoist motor and driving generator, which remains closed at all times except in an emergency. Thus it is necessary to handle only the field current, and the control apparatus can be simple and of light capacity, resulting in a minimum of maintenance and repair expense and a minimum of delay. In this type of control, a motor generator set takes the place of a complicated set of full-capacity contactors, relays, and resistors, with their large energy consumption. In such a dumper as this, requiring equipment large enough for rapid handling of coal, rheostatic control is practically out of the question.

Another advantage of the Ward Leonard control is that high-voltage alternating current, as well as low-voltage direct current, is available, thus giving greater accuracy of speed control with stable creeping speeds on both hoisting and overhauling loads. Very smooth acceleration and deceleration result in less cable wear and strain on equipment. Deceleration practically to a standstill is obtained with electrical regenerative braking, thus eliminating wear on mechanical brakes.

Voltage fluctuations on the incoming power do not affect the motor torque because it is dependent largely on the armature current. The speed torque curves obtained on all controller points are relatively flat, causing the time cycles to be equal regardless of the size of cars, and the limit switch setting is satisfactory for all loads. This feature is particularly desirable at the hinge. A speed ratio of 7 to 1 from the first to the last controller point is easily maintained.

The control provides special features worthy of note. The maximum speeds for hoisting and lowering may be independently adjusted. This makes it possible to lower the barney or cradle with an empty car at a considerably higher speed than is possible for hoisting a loaded car and still maintain complete control of the drive. Protection against over speed is also provided, resulting in the application of both mechanical and electrical braking. Emergency switches, conveniently located, can be used by the operator to stop the drive.

The control, in general, is so interlocked that an abnormal condition in any of the motors or motor generator sets prevents operation until normal conditions have established. Should there be a failure of any circuit while the equipment is in operation, the operation is automatically stopped.

With a given gross weight to handle, a rope load curve is plotted for the operation of the barney and cradle. The rope load curve determines the duty cycle required on each movement.

The barney and cradle controls are designed to meet the conditions imposed by these duty cycles. The size of the generators and motors is likewise determined by this curve. The barney control is semi-automatic, the operator having full control at all times. If the cradle is not seated, the car is automatically slowed down and stopped at the top of the incline. The control is also interlocked to prevent the operator from pushing the car onto the cradle unless the cradle is within 2 ft. of being seated. Should the cradle be stopped within this distance, the barney operator must stop the car on the incline. The car is stopped on the cradle by means of a car retarder.

These features are obtained by the use of the geared limit switch of the traveling nut type, with quick-acting contacts and the track-type limit switch at the top of the incline. Both sides of the line are broken by these switches, thus removing the possibility of over travel, due to grounds in the electrical system.

The cradle drive is similar to the barney drive, except that it is entirely automatic, with speed control by the operator if desired. Because of the flat speed torque curves of this type of drive, it is particularly well adapted to the cradle hoist up to the capacity of the machine, on either a positive or overhauling load. Hence, the speed of engaging the hinge is practically independent of the size of car or temperature conditions. This also indicates why rheostatic control with series motors is not suitable for this drive.

After the limit switches are once set there is no necessity for changing them regardless of the size of the car being handled. In order automatically to take care of

the slow-down to engage the hinge at different elevations, the geared limit switch is driven through a differential gear, one shaft of which is driven by the screw-girder machinery and the other by the cradle machinery. Any change in the position of the hinge makes a corresponding change in the position of the traveling nut on the geared limit switch. This is also true for the slow-down and stop on the hoisting position. Slow-down and stop lowering is controlled by track-type limit switches on the structure.

Structural Design and Details

By WENDELL P. BROWN

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
CONSULTING ENGINEER, CLEVELAND, OHIO

THE structural and mechanical parts of the south car dumper were designed and built to provide for loaded and empty cars of the following capacities:

	Maximum		Minimum	
Weight of car and coal, in pounds	car, 90,000; coal, 240,000	330,000	car, 30,000; coal, 60,000	90,000

In addition to the live and dead loads, there was added to provide for impact to the parts as enumerated:

Platen	50 per cent of the weight of car and coal
Cradle	50 per cent of the weight of loaded car, cradle, and platen
Dumper frame	50 per cent of the weight of loaded car, cradle, and platen
Pan and pan girder	50 per cent of the maximum amount of coal that can be placed in the pan

The unit stresses are in accordance with The New York Central Railroad Company's Specifications for Steel Railroad Bridges (1917).

DESIGN OF STATIONARY SUPERSTRUCTURE

The stationary part of the superstructure of the dumper proper is a structural steel tower, 100 ft. 9 in. high, from dock level to the sheave-supporting platform, with an additional height from this platform to the top of the derrick mast of about 36 ft. 3 in., a total of 137 ft.

Parallel to the dock front, the dumper is 73 ft. 6 in. long, center to center of columns, allowing 64 ft. clear between the front columns, providing for a car 58 ft. 6 in. long to pass between the columns while rotating for dumping. The width of the dumper tower (perpendicular to the dock line) is 39 ft. 2 in. from center to center of columns at the bottom, and 24 ft. 6 in. at the top (at supporting platform), the front columns of the dumper being vertical and the rear ones inclined.

Throughout, the entire structure is thoroughly braced with structural steel members capable of resisting tension and compression, and with all connections riveted. The two front columns are T-shaped, the top bar of the T being a plate girder 36 in. back to back of angles, and the stem being a 42-in. plate girder, with the base of the T an 18-in. I-beam. This shape gives the necessary section and affords facilities for the vertical movement of the cradle and pan girder along the columns. Along the top bar of the T are angle guides in which the ends of the pan girder slide in finished guide blocks, while the inside end of the top bar of the T acts as a cradle guide.

The two rear corner columns, which are inclined, are made up of two 15-in. channels with 28-in. cover plates. The center rear column is supported in one plane only, that of the back of the dumper. It is approximately 95 ft. long and has a plate girder section 48 in. deep at mid-height and 14 in. at the upper and lower ends.

On the inclined back face of the dumper tower six tracks are built; the two at the ends are for the cradle counterweights and the four inside ones are for the car clamps and platen counterweights. In the rear of the dumper tower and near the center of it, there is a structural steel tower which serves as a support and guide for the cradle-hoist drum counterweight and also as a support for the stiff leg of the material derrick that is on the top of the dumper on the sheave platform.

MOVABLE PARTS

The movable parts are the cradle, pan girder, and pan with the telescopic chute and trimmer, together with their counterweight equipment. The cradle is an L-shaped structural steel frame designed with special regard to lateral stiffness, and weighs, with the loaded car of maximum capacity, about 645,000 lb. It is designed to carry adequately this load, with 50 per cent additional for impact, not only in its normal or vertical position but in any position during the 160 deg. of rotation, (nearly upside down).

As the cradle is elevated from the receiving position, it is in contact with the two front tower columns by means of cast-steel, rubber-tired rollers, 27 in. in diameter, rolling on a finished track on the columns. At each end of the vertical side of the cradle is a cast-steel open hinge which, as the cradle is elevated, engages a similar open-hinge hook on the pan girder, causing the cradle with the loaded car to rotate until the coal slides into the pan.

To aid in elevating and rotating, the cradle and car are counterweighted by means of two counterweights connected to six wire ropes, $1^1/_4$ in. in diameter, passing over 75-in. sheaves located on the sheave platform and extending down to the vertical side of the cradle.

Because of the various widths of cars in use, the cradle is provided with a platform or platen, moving transversely on the cradle and consisting of an 18-in. deck I-beam girder span supporting the track rails on which the car is carried during the operation of elevating and rotating the cradle. The platen rolls on 16 cast-steel wheels, 18 in. in diameter, bronze-bushed on forged-steel axles and is moved automatically by means of counterweights to the vertical side (toward the boat)

of the cradle, as the cradle is elevated, and is held firmly against the wood blocking on this side of the cradle by the platen counterweights. The loaded car engages four clamps which hold it firmly on the platen and cradle by means of counterweights rolling on tracks supported by the inclined rear tower columns.

After the car is dumped and rotated back to a vertical position, the platen is automatically moved back to its receiving position by means of cast-steel bell-cranks engaging the fixed portion of the structure under the cradle. The platen is locked in its elevating and rotating position on the cradle by an automatic device operated in connection with the bell-crank.

On the platen, car retarders are provided for retarding and spotting the loaded cars on the cradle. On account of the limited space available and the movement of the platen, these retarders are of somewhat different construction from the retarders in use in the tracks elsewhere, although similar in principle—that of pressing a shoe against each side of the car wheels just above the rails by means of a system of levers actuated by compressed air controlled by the barney-haulage operator.

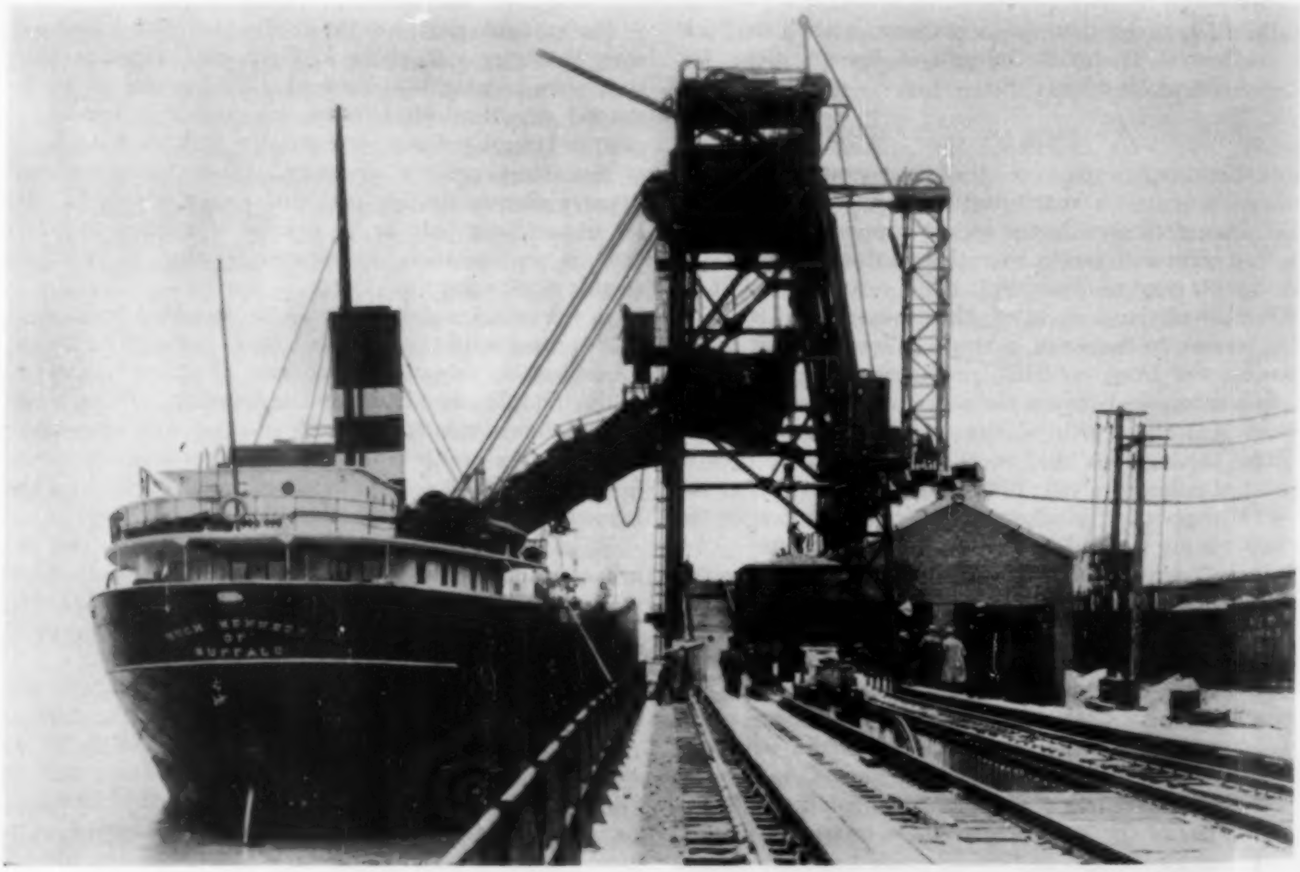
The pan girder is a double webbed, box-plate girder, 66 in. deep by 24 in. wide, installed between the front vertical columns of the dumper, and carries the pan, telescoping chute, and trimmer, and, in addition, the hinges about which the cradle rotates. It is raised and lowered by two vertical forged-steel screw shafts operating through heavy special bronze nuts trunnioned in its ends. The upper end of each screw shaft is carried on a roller thrust bearing, and the ends of the pan girder are provided with forged-steel guide-blocks moving between guides on the vertical front columns of the dumper.

A combination of stresses affects the pan girder as it supports the pan with its load of coal and with the eccentricity of hinge connections, combined with the variable angles of inclination of the pan. It is also subject to the stresses from the hinges about which the cradle and its load rotates, making it an interesting structural designing problem beyond the limits of this paper. The operation of the screws for elevating and lowering it is by electrical control which has been fully described.

The pan consists of a structural steel frame with a plate girder on each side supporting a floor of double plates, the upper one being a wearing plate which can be replaced as worn out by the movement of coal sliding on the pan floor. The side girders of the pan are hinged at the pan girder, and the floor of the pan is also supported by hinges on the side of the pan girder, the outer end of the pan being supported by hoisting cables.

At the outer end of the pan, and above the telescopic chute, is the cabin for the pan and chute operator. The limits of inclination of the pan are from 35 deg. below the horizontal (for loading) to 60 deg. above horizontal when in its vessel-clearance position.

At the outer end of the pan is installed a telescoping chute built so that it can be raised and lowered or swung in a vertical plane about a hinge point at the lower end of the pan. The lower end of the chute is provided with a deflector for trimming the coal fore and aft of the vessel.



BARNEY PUSHING LOADED CAR ONTO THE DUMPER
Barney Pit in the Foreground

Heavy Duty Wire Ropes and Sheaves

Their Design, Testing, and Use

By B. R. Leffler
Member American Society of Civil Engineers
Engineer of Bridges, New York Central Railroad Line West of Buffalo

Wire ropes are of such general use in engineering construction and operation activities that a presentation of the results of studies made by the New York Central Lines in connection with the design and operation of their Toledo Coal Handling Dock is very timely. Mr. Leffler has here made a valuable contribution to our present knowledge of this subject. In discussion, Mr. Meals brings to the reader the conclusions of one of the large manufacturers of such cables, while Mr. Strachan makes an interesting comparison between six formulas used for determining stresses. These papers were presented before the Waterways Division of the Society at the Cleveland Convention, in July 1930.

Wire ropes are an important feature of car dumpers for the Great Lakes coal trade. Not enough attention has been given to the diameters of sheaves for such heavy service; too much reliance has been placed on the recommendations given in the pocket-books or catalogues of wire rope manufacturers. The catalogue specifications do not make proper and sufficient allowance for the bending of the rope over the sheaves, and for the damaging effects of reverse bends. As a basis for the invitation to bidders, the New York Central Lines Specifications for Railroad Bridges, 1917, and for Movable Railroad Bridges, 1921, were adopted for the Toledo Coal Dock and Car Dumper Plant with certain modifications. These specifications are quite well known to engineers. The requirements are similar to those given in the specifications, in the 1929 *American Railway Engineering Association Manual.*

It was thought that the Specifications for Movable Bridges were rather severe with respect to the bending of wire ropes over sheaves, and that the requirements would lead to abnormally large sheaves. In vertical lift bridges, large sheaves are indeed desirable on account of the size and importance of the structure. This is also true for car dumpers, where the service is very severe; but it is usually impracticable to obtain as large sheaves as are desired in movable bridges. A further study of the requirements of wire rope was then made.

INVESTIGATIONS UNDER WAY

The American Society of Mechanical Engineers, with other technical societies, is making a careful study of wire rope specifications and requirements for different kinds of service. The effects of the bending of wire ropes over sheaves are also to be studied by Committee XV, of the American Railway Engineering Association from the viewpoint of wire ropes for vertical lift bridges.

In 1925, the New York Central Railroad Company built a dumper at Toledo for which a sheave diameter 45 times the diameter of the rope was allowed, and no attention was paid to reverse bending. It soon became apparent that the effects of small sheaves and reverse bending were quite marked. When the time came for building a second dumper, three years later, more rigid requirements for wire ropes were included.

The following specifications were adopted:

The sheaves shall be single-scored, and of cast steel, with turned grooves to fit the ropes. The pitch diameter of the sheave shall be not less than 60 times the diameter of the rope. Reverse bends shall not be used.

The total unit tension in the ropes for the counterweights, cradle hoist, and apron hoist, shall not exceed one-fourth of the unit ultimate strength of the rope. For all other ropes, the corresponding limit shall be one-third.

Wire ropes shall have 6 strands of 19 wires each.

If a wire rope is bent over a sheave, the bending stress and the permissible load on the rope shall be calculated as follows:

Let P = the total pull or permissible load on the ropes in pounds
f = unit extreme fiber stress in largest individual wire due to bending
E = modulus of elasticity = 28,500,000
a = cross-sectional area of rope, in square inches
d = diameter of the largest wire, in inches
D = diameter of sheave, to center of rope, in inches
S = greatest unit tension allowable
L = angle of helical wire with axis of strand
B = angle of helical strand with axis of rope

Then

$$f = \frac{2}{3} \times \frac{E\,d\cos^2 L\cos^2 B}{D} \quad [1]$$

$$P = a(S - f) \quad [2]$$

$$P = a\left(\frac{S - 0.6\,E\,d}{D}\right) \quad [3]$$

TEXTBOOK THEORY CRITICIZED

The builders of these car dumpers thought that the requirement of the diameter of sheaves 60 times the diameter of the rope was too severe and unnecessary. In the usual textbook treatment of wire rope in bending over a sheave, it is assumed that the ordinary beam formula is applicable, the formula being applied to the largest wire in the rope. In wire rope, the curvature (which is determined by the radius of the sheave) is given, and the bending stress is determined from such curvature. Mechanical engineers have criticized the bending theory, as thus applied, and some claim that the helical effect of the individual wires in the strands, and of the strands themselves, has a considerable modifying influence.

R. W. Chapman, an Australian mining engineer, studied the question experimentally and theoretically, and published in the October 1908, *Engineering Review,* London, formulas for calculating the extreme fiber stresses in the individual wire for a rope bent over a sheave. His formula takes into account the helical

condition of both the individual wires and the strand, and was adopted by the American Railway Engineering Association in its Movable Bridge Specifications, of 1929. The foregoing formulas are Chapman's, modified by substituting a modulus of elasticity two-thirds that of steel. The reasons for this modification will be noted later.

Some mechanical engineers and manufacturers claim that, even with the modifications made by Chapman, the bending effect of wire rope is not correctly given by his formula; that the modulus of elasticity of the rope itself has a modifying influence on the bending. The modulus of elasticity differs very much from the usual stretch modulus of steel and is largely determined by the helical condition of the wires and strands. The modulus of elasticity of the rope as a whole is about 8,500,000. This should be compared with 30,000,000—the usual modulus of steel.

DETERMINING STRETCH MODULUS

Examine the effect of the modulus of elasticity of the whole rope. The fundamental expression for all kinds of bending is $E\frac{c}{R}$, in which R is the radius of curvature, and c the distance from the neutral axis to extreme fiber. In computing the stresses in a simple beam, it would be correct to ascertain the actual radius of curvature, either by calculation or by exact measurements, and use it as indicated. If the curvature could be measured accurately, the idea of a moment of inertia or a sectional modulus would not enter explicitly at all.

Consider a single helical wire, like a bird-cage spring. The stretch modulus will be determined largely by the angle of the helix. Because the wire is a helix, each element has an initial curvature. Suppose the helical wire is bent over a sheave, the curvature of each element will then have a new value. The new value depends on the angle of the helix and so does the stretch modulus of the wire as a helix; but this does not mean that the stretch modulus of the helix should replace E.

It appears that Chapman has solved the problem in that he actually calculated the new curvature of an element, showing how the angle of the helix enters into the new value of the curvature. After the new curvature is known, the usual modulus of elasticity, E, must be used. This modulus stands for an inherent quality of the material, and is independent of the shape of the metal, whereas the stretch modulus of the rope is not independent of the shape.

Chapman's formula shows that for a close-coiled wire or spring the bending stress is small. For this condition, however, other stresses now become important, such as torsion and shear. In wire rope, on account of the small angle of the helix, torsion and shear are negligible.

DO STRESS FORMULAS AGREE

It is further claimed that Chapman's formula and others of similar import do not represent the actual bending stresses in the wire rope, because they do not check with experiments. It appears, however, that it would be very difficult to check the ordinary formula for stresses in beams, for sections in which the bulk of the area is found close to the neutral axis; as an example, if the section of the beam were that of an equilateral triangle, the extreme fiber would be at one of the apices of the triangle. For such a section, it would be difficult to measure close enough any deflection of the beam which would detect the deformation of the extreme fiber. The deformation of the extreme fiber is a relatively small portion of the total deflection of the beam. A circle is not quite as extreme a section as a triangle; but, even in a circle, the area of the remote fibers is rather small, compared with the area near the neutral axis.

As an illustration of experimental results giving a false indication, a central load was applied to a bar $^7/_8$ in. in diameter as a beam with a span of 7 in. Plotting the deflections against the calculated extreme fiber stresses showed that, apparently, the straight-line proportion held until the extreme fiber stress reached about 60,000 lb. per sq. in.; but the elastic limit for a tension test is about 42,000 lb. Why this difference? The difference is only apparent; the elastic limit is no greater in bending than for the straight tensile test. The experimenter could not measure the deflection of the beam accurately enough to detect when the elastic limit was reached. For an I-beam section, the result would have been otherwise, because the bulk of the material becomes a marked cause of the deflection; the stretch is readily detected in the deflection.

BENDING EFFECTS TABULATED

About the time that the subject was being considered, *Technologic Paper No. 229*; issued by the U. S. Bureau of Standards, came to hand. This contains the results of experiments on wire rope bent over sheaves. From results found in Table IV of that paper, a fairly accurate representation of the bending effect of wire rope over sheaves for static ultimate loads was obtained. These results are here shown in Table I.

TABLE I. BENDING EFFECT OF WIRE ROPE OVER SHEAVES

DIAMETER OF ROPE IN INCHES	DIAMETER OF SHEAVE, IN INCHES 10	14	18
	ULTIMATE STRENGTH, IN POUNDS*		
$^5/_8$	28,170	39,910†	30,700
$^7/_8$	51,470	56,300	58,390
$1^1/_4$	99,070	106,320	110,630

* Ultimate strength is for static loads, that is, sheaves were not rotating.
† This result is not consistent, as it shows the rope stronger for a sheave 14 in. in diameter than for one 18 in. in diameter.

Assume that the ultimate strength, U, of a wire rope bent over a sheave can be written in the following terms:

$$U = a\left(u - \frac{K\,d}{D}\right) \quad . \quad . \quad . \quad . \quad . \quad [4]$$

in which K replaces the modulus of elasticity and other factors of Chapman's formula; it should be regarded as a factor of bending, to be determined from the experimental results which are given in Table I.

For the present purpose, u has a value of 220,000 lb., this being the ultimate strength of the steel composing the individual wires of the rope. Taking the results of Table I and using Equation 4, eight values of K were found, varying between 7,200,000 and 8,400,000, with one inconsistent value of 6,500,000. The average of the eight is 7,720,000 lb. Omitting the one erratic value, the average is 7,900,000 lb.

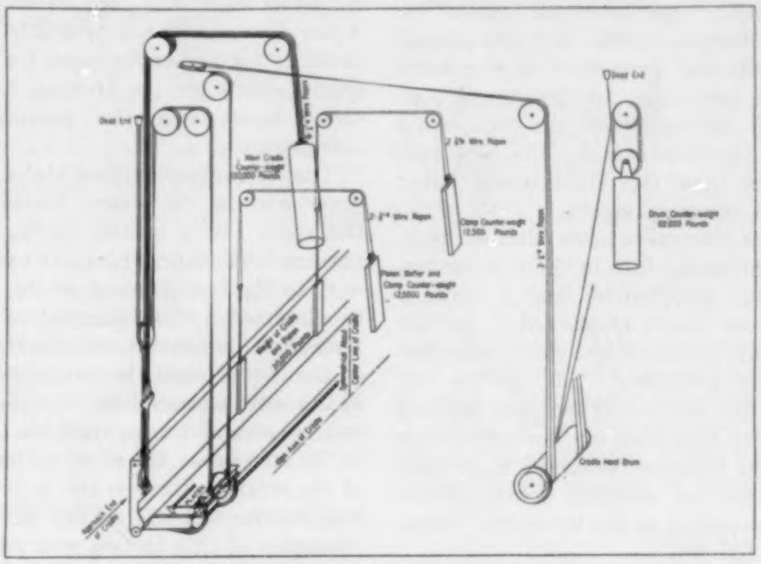
In view of the uniform values of K, it is fair to take this average result, as a factor in the bending effect in a

rope over sheaves, under static ultimate loads. This is a purely empirical constant and, of course, is subject to all the uncertainties and limitations found in experiments to determine the strength of materials beyond the elastic limit.

Bearing in mind that these results are for wire ropes under a static load—that is, sheaves not rotating—it is necessary to use a larger value of K to take care of sheaves in actual rotation, and for reverse bending. Furthermore, K must approach E as the unit of stress falls below the ultimate value. A value of K of about two-thirds of that used in Chapman's formula should be safe for wire ropes used in car dumpers and not subject to reverse bending. The formula for a working load can now be written:

$$P = a\left(S - \frac{0.6\,E\,d}{D}\right)$$

Smaller values of K can be used where it is impossible to obtain larger sheaves, and where breaking of occasional wires is not important and the cost of replacement not excessive. Where such smaller values are used, it should be expected that the rope will suffer correspondingly greater deterioration under wear.



ARRANGEMENT OF CRADLE HOIST ROPES
Toledo Coal Loading Docks

EFFECT OF OVERSTRESSING

Using a value of K considerably less than E means that the extreme fibers in the individual wire may be stressed above the elastic limit. This overstress does not necessarily mean failure. Breaking of the wire will only occur after an enormous number of applications of the stress, providing the overstress is not too large. In the meantime, the wires may wear out by chafing, thus breaking by loss of cross-sectional area.

As noted, the specifications did not allow reverse bends in the wire rope. Reverse bending can only occur when the rope passes from one sheave to another, the sheaves being in the same plane or in parallel planes. Bends caused in a rope by passing from a sheave, in a certain plane, to another sheave, in a plane at right angles to the first plane, were not considered as reversed. For this kind of bending, the extreme fibers of the wires that were being bent in the first plane assumed the position in the neutral axis in passing over the second sheave, and hence were not stressed. The importance of avoiding reverse bends and sheaves that are too small is illustrated by the actual results shown in Table II, which are taken from the two car dumpers, with different brands of rope.

In 1929, the second car dumper, with relatively large sheaves, handled about 3,400,000 tons of coal. A car can be dumped in a minute, but this rate cannot be maintained on account of other causes. It will thus be seen that the service requirements of wire rope are very severe. The coal was handled with one set of ropes, and the same ropes are still in service. On the first dumper, as indicated in Table II, the life of the wire ropes was much shorter. Renewal of ropes costs about $5,000, which includes material and labor; but in no wise takes into account the delay to the dumper. It takes about 16 hours to renew all the ropes. While the total cost per ton for renewal of wire ropes is very small, it is desirable to avoid delays in the middle of the season.

DUMPER GOOD TESTING APPARATUS

Table II shows rather interesting results for different makes of rope. It is evident that the first car dumper is a good testing apparatus. The brand of rope giving the best service, as judged by the larger tonnage handled, has the desirable quality of not fraying when a wire breaks. The broken wire remains in place, instead of separating itself from the surrounding wires, and thus becoming bent and crushed into the adjacent wires, as the ropes pass over the sheave. The objection to the broken wire remaining in place is that the rope must be given closer inspection to detect the broken wires. The fraying out of a broken wire causes the adjacent wires to become nicked and broken, and also causes roughening of the groove on the sheave.

TABLE II. WIRE ROPE SERVICE, FIRST CAR DUMPER

Brand of Rope	Counterweight Ropes, Two Reverse Bends, Tonnage	Cradle Loop Ropes, One Reverse Bend, Tonnage
A	2,973,000	3,212,000*
A	2,099,000	———
A	2,628,000	———
B	1,715,000	1,715,000
B	1,133,000	1,763,000
B	1,721,000	2,812,000
B	1,436,000	2,438,000
B	1,141,000	2,091,000
B	1,750,000	———
B	2,168,000	———
C	644,000	Not used
D	810,000	Not used

* These ropes were not removed at the end of the season, but were carried over into the next season.

In conclusion, it is not believed that static tests on the ultimate strength of wire ropes bent over a sheave, as given in *Technologic Paper No. 229*, are of great value when considered alone. Any testing of wire rope should be made with a rope in motion and subject to reverse bends. The results of service tests, such as those shown in Table II, are regarded as of as much practical value as laboratory tests. In a few years engineers will be able to show the results of the better sheave and the rope design on the second dumper, as compared with the first. The short time in which the second dumper has been in use already points to much better rope service.

An Analysis of Bending Stresses

By CASPER D. MEALS

ASSOCIATE MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
CHIEF ENGINEER AND MANAGER, WIRE ROPE DEPARTMENT,
NEW YORK CORDAGE COMPANY

LIKE so many similar specifications, those on Movable Railroad Bridges of 1921 are antiquated. The items concerning physical properties of the wires need revision, and data pertaining to the strand construction, rope lay, and lubrication of the rope could well be included. The specifications for the new railroad vertical-lift bridges over the Hackensack River are much more complete in every respect.

Unfortunately, the manufacturers have withheld publication of wire rope engineering data in their literature, although, in 1926, Walter Voigtlander and I wrote a series of eight "Wire-Rope Users Handbooks" for the American Cable Company, in which was given considerable data not previously published. Mr. Leffler has given much thought to the subject of bending stresses in wire rope; but I believe that they are not susceptible to accurate mathematical analysis because the problem is a practical rather than an abstract mathematical one, due to the many variables that are involved. Some of these variables are as follows:

1. Strand construction and relation of wire sizes
2. Length of strand and rope lays
3. Quality and size of center in the rope
4. Lubrication
5. Arrangement and condition of sheaves

The bending stress formula, Equation 1, like all others I have investigated, is totally inadequate to take these variables into consideration. The value of "E" for high grade steel rope wire is approximately 26,000,000 lb. per sq. in. instead of the 28,500,000 given, and just why a correction factor of $^2/_3$ was used in Equation 1 is not clear.

Furthermore, the results of tests of ropes over sheaves, as reported in *Technologic Paper No. 229*, cannot be taken as a criterion on this subject, regardless of how nicely the analysis given seems to fit the anticipated modulus values. The premises on which they are based are not fundamentally correct. Bending stresses in an operating rope must necessarily be considered for intelligent designing and, as the derivation of an equation covering these stresses is empirical, the writer prefers using the formula $f = \frac{E_r d}{D}$ in which:

d = diameter of largest outer wire in strand

$\frac{E_r d}{D}$ = modulus of elasticity of rope in pounds per square inch, best determined by test, or approximately as follows:

CONSTRUCTION	MODULUS OF ELASTICITY
6 × 7	14,000,000
6 × 19	13,000,000
6 × 37	12,000,000
8 × 19	10,000,000

For new, unstressed ropes, the E_r values will not be as high as these. After being in service, however, ropes will show these values; it is old ropes that show broken wires due to excessive bending stresses and not the new ropes.

Unfortunately, E_r values cannot be evaluated with any degree of accuracy because variables 1, 2, and 3 are involved, and the size of the machine on which the rope is fabricated will also influence the results. A rope fabricated on a 60-ton closing machine will show a higher E_r value than the rope of a 15-ton closing machine. A low E_r value is not desirable for some purposes, particularly for suspender ropes for suspension bridges, and specifications for the Hudson River Bridge and several others have taken this manufacturing fact into consideration.

The maximum bending stress is not necessarily in the outer wire of the strand farthermost from the axis of the rope. In a strand having the full helical shape, the outer wires, under certain operating conditions, break next to the hemp center of the rope where they cannot be detected. For example, if the forces acting, the tension in the strand and the reaction of the sheave, are in the direction of the curvature of the helix, the stress in the outer wires will be very much less than if the forces on the strand are against the curvature of the helix. In the latter case, the effect is that of "breaking the back" of the strand; the less the helix is set in the strand, the less detrimental will be this action. I have seen many examples of this fact in wire ropes taken out of service and examined, sometimes after a "mysterious" failure of the rope.

Reverse bends and small sheaves are costing the wire-rope users a princely sum annually, and for this reason alone they should be eliminated. Where a rope is subjected to reverse bends, it is well to remember that an 8-strand regular lay rope or a 6-strand Lang Lay rope will give better service than a 6-strand regular lay rope; but some judgment must be used in choosing between them because of certain inherent limitations of these two ropes.

Where reverse bends are unavoidable, the sheave over which the rope makes a reverse bend should be increased in diameter at least 33 per cent, although there is a limit to this, as it applies principally where the sheaves are relatively small. Tests were made of $^5/_8$-in. ropes on a wire-rope fatigue-testing machine, in which the rope was operated under 2,000-lb. tension over three 20-in. sheaves with a reverse bend in the rope, but on which the sheaves at the ends of the machine were 14 in. In no test did the rope break over the 14-in. sheaves.

Tests on ropes of the same size, with the same tension, showed that the "bending life" over the 20-in. sheaves is greater than that over the 12-in. sheaves by the following ratio, indicating the importance of using as large sheaves as possible:

$^5/_8$ in. 6 × 27 rope, with hemp center	7 to 1
$^5/_8$ in. 6 × 19 rope, with wire center	11 to 1
$^5/_8$ in. 8 × 19 rope, with hemp center	4.5 to 1

Small sheaves should be avoided because of another important consideration; that is, excessive unit radial pressure of the rope on the sheave, leading to an acceleration of wear of both the rope and the sheave. This unit radial pressure M is a function of the tension P

of the rope, the radius R of the sheave, and the rope diameter d, or

$$M = \frac{P}{Rd}$$

The allowable M values for various constructions of ropes and kinds of sheave equipment may be taken as given in Table I.

TABLE I. ALLOWABLE M VALUES

Material of Sheave	Regular Lay Ropes			Lang Lay Ropes: Round Strand		Lang Lay Ropes: Flattened Strand	
	6 × 7	6 × 19	8 × 19 / 6 × 37	6 × 7	6 × 19	6 × 13	6 × 30
Cast iron	330	550	700	400	600	500	800
Cast steel	650	1,100	1,200	800	1,200	1,000	1,700
Cast manganese steel	1,500	2,300	3,200	1,800	3,000	2,300	3,700

Values of M in excess of those given will lead to wear of both the rope and sheave equipment.

It is quite interesting to note that a formed rope gave the best service on the dumper described by Mr. Leffler. Such a rope undoubtedly requires closer inspection to detect broken outer wires, but experience will gradually eliminate this difficulty as the inspector becomes familiar with the characteristics of breaks in the wires.

Six Formulas Compared

By R. C. STRACHAN

MEMBER AMERICAN SOCIETY CIVIL ENGINEERS
CONSULTING ENGINEER, NEW YORK, N.Y.

THE wide variation in opinion as to the effect on a rope of passing it around a sheave or a drum is evidenced by the great divergence in specified requirements, as expressed in formulas intended to state this effect in mathematical terms. These formulas are all modifications of the fundamental expression:

$$f = \frac{Ed}{2R} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad [1]$$

in which f is the extreme fiber stress in a rod of diameter d and elastic modulus E, due to the bending in a curve of radius R.

This formula is far from a true statement of the effect of bending, if the rod is considered as a constituent wire of a rope, because in this case the wires are twisted into strands, and a number of them are combined to form the rope—sometimes with one, sometimes with several hemp cores. When the rope is under stress the physical properties of the core, and the existence of the helical angles formed by the wire with the axis of its strand and by the strand with the axis of the rope, are factors of the greatest importance.

These facts have of course long been well known, and both theoretical analysis and experimental research have been applied to the question of the action of forces on a bent rope.

In the extremely valuable article by Mr. Chapman, to which reference is made by Mr. Leffler, the conclusions of earlier investigators are summarized, their defects indicated, and a new formula is presented for bending stress, which takes account of the diameters of wire and sheave, the helical angles of wire and strand, and the modulus E. Chapman's formula is:

$$f = E\frac{d}{D}\cos^2 a \cos^2 b \quad . \quad . \quad . \quad . \quad [2]$$

which is of the same form as the author's Equation 1, in which L and B denote the angles, instead of a and b.

By taking average values, about 18 deg., for a and b, Chapman obtains the formula:

$$f = \frac{0.81\ Ed}{D} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad [3]$$

and finally, using x for the rope diameter, $9\,d = x$ for 5×7 rope, and $15d = x$ for 6×19 rope, with $E = 28{,}500{,}000$, he gives:

$$f = 2{,}587{,}000\frac{x}{D} \text{ for } 5 \times 7 \text{ rope} \quad . \quad . \quad . \quad [4]$$

$$f = 1{,}552{,}000\frac{x}{D} \text{ for } 6 \times 19 \text{ rope} \quad . \quad . \quad [5]$$

J. F. Howe, Chief Engineer of the American Steel and Wire Company, concludes in *Transactions* (American Society of Mechanical Engineers, Vol. 40, 1918), that if the modulus E is regarded as the stress-strain ratio of the rope as a whole, 12,000,000 is a suitable value, and the bending stress may be written

$$f = 12{,}000{,}000\frac{d}{D} \quad . \quad . \quad . \quad . \quad . \quad . \quad [6]$$

His tables, calculated by this formula, give stresses of about one-half the amount which would be given by Chapman's formula, and about two-thirds that given by the author's Equation 1.

In his discussion of Mr. Howe's paper, also in *Transactions* (American Society of Mechanical Engineers, Vol. 40, 1918), Shortridge Hardesty, M. Am. Soc. C.E., derives

$$f = \frac{Ed}{D}\cos a \cos b \quad . \quad . \quad . \quad . \quad . \quad [7]$$

which, for average angles, a and b, rope diameter $C = 15\,d$, and $E = 27{,}500{,}000$, is finally stated

$$f = 1{,}700{,}000\frac{C}{D} \text{ for } 6 \times 19 \text{ rope} \quad . \quad . \quad . \quad [8]$$

In the description of the erection of the eye-bar cables of the Florianopolis Bridge by D. B. Steinman and W. G. Grove in TRANSACTIONS (American Society of Civil Engineers, Vol. 92, 1928), the results of tests of 1-in., 6-strand hoisting ropes with hemp centers are tabulated. The tests were made for the purpose of finding the actual stress-strain modulus E for the ropes intended to be used, and the value shown under conditions of loading most nearly comparable with those of the present discussion is 8,400,000. This would of course give still smaller values for f than those obtained by Mr. Howe.

For a given class of rope the lay, that is the angles L and B of the author's Equation 1, may be considered constant, and on this assumption the bending stress might be written:

$$f = \frac{kEd}{D} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad [9]$$

in which E is the elastic modulus 28,500,000, and k is an

experimental coefficient. According to the various formulas cited above, we should then have for the value of k:

FORMULAS	VALUE OF k
Equation 1	1.00
Leffler	0.60
Chapman	0.81
Howe	0.42
Hardesty	0.90
Florianopolis ropes (approximately)	0.30

The extremely low value for the Florianopolis Bridge is accounted for by the fact that the ropes were new and were tested with static loads. A substantial increase in E would undoubtedly be shown if it were possible to subject these ropes for a considerable time to the conditions of a tramway cable, and subsequently test them. Equation 1 is inapplicable to ropes except in so far as it shows the upper limit of k. As for the other four values, none of them can be accepted as correct for use under all circumstances. The adoption of a lower value in designing means, in general, a shorter life for the rope; but the speed, number of reverse bends, variation in load, and state of lubrication must all be taken into account.

A high rate of rope renewal may be relatively unimportant in one installation and of the utmost importance in another. Therefore, the choice of a value for k should be governed by the conditions of the particular job and the known results in work of a similar character. Mr. Leffler, with knowledge of the effects of three years' operation on the earlier installation, is in a position to change his requirements in such a way that former rope and sheave troubles will not develop in the new work, and his revised specifications increasing sheave diameter, reducing maximum rope tension, and modifying the bending stress formula, appear to be justified by such experience; but the coefficient 0.6, adopted in his Equation 3, might be unsuitable for the next job unless all conditions and requirements were exactly duplicated.

NEW YORK ANCHORAGE, FORT LEE BRIDGE

Showing method of fastening "C" and "D" cables to anchors

The enormous size of the anchor block may be noted by comparing it with the workmen. This bridge, connecting Fort Washington on the New York side with Fort Lee in New Jersey, crosses the Hudson River opposite 179th Street, New York City

Filtering Materials for Trickling Filters

Importance of Selection, Operation, and Maintenance

By William E. Stanley

Associate Member American Society of Civil Engineers
Chairman, Committee on Filtering Materials for Water and Sewage Works
Hydraulic and Sanitary Engineer, Pearse, Greeley, and Hansen, Chicago

FIFTEEN to thirty per cent of the cost of a sewage treatment plant is represented in the filter material. Fully one-half of the work of a treatment plant in reducing the oxygen demanded by the effluent is performed in the filters. Mr. Stanley's paper deals with the importance of the selection of a proper filter media, with regard to size, durability, roughness, porosity, depth, and manner of placing, considered in relation to its effect on filter-bed operation. Filters may be kept clean, Mr. Hommon explains, or having become clogged may be so operated that they will become self cleansing. The relation between the filter media and clogging is discussed by Mr. Jones, while a clear cut, accelerated-test method for determining durability of material for filters receives attention from Dr. Kriege. These four papers of the Committee on Filtering Material, presented before the Sanitary Engineering Division at the Society's Cleveland Convention, merit wide-spread attention among sanitary engineers.

EXPERIMENTAL work of the Massachusetts State Board of Health, about 1890, and similar experimental work in England at a little later date mark early steps in the development of trickling filters.

As indicated by an incomplete inquiry in 1925, there were upward of 400 trickling filter installations in the United States serving cities with an aggregate population of something over 4,000,000 people. Many other installations have been constructed during the past five years. The cost of the filter material represents from 15 to 30 per cent of the total construction cost of sewage treatment works, including trickling filters. The work done by the filters represents possibly 60 per cent of the work of the treatment plant as measured in terms of the demand on the oxygen resources of the waterway into which the plant effluent is discharged. Thus trickling filter material is an important item in the consideration of sewage treatment processes. Further, much of the success of the operation of trickling filters depends on proper attention to the filter media during the design, construction, and operation of such installations.

A committee appointed by the Sanitary Engineering Division in 1925 to consider the general subject of "Filter Materials for Water and Sewage Works," has devoted its principal efforts to date to questions regarding the selection of trickling filter media from the viewpoint of durability. More recently, the work of the committee has been extended to include such items as size and type of material, loadings, and the like. It is obvious that a study of filter materials cannot be completed without consideration of the filter bed as an operating unit. From the point of view of an engineer charged with the selection of the type of treatment or the design of filter units for a given situation, trickling filter materials should be considered with particular reference to the question of design as determined by the character of the raw sewage and the extent of treatment required.

APPLIED SEWAGE LOAD MUST BE INVESTIGATED

Basic principles of trickling filter operation include application of the proper sewage load to a given quantity of filtering material in a trickling filter and the relation of such sewage load to the physical characteristics of the filtering material. The problem involves, in part, the standardization of sewage analyses for measuring the work done by trickling filters and a generally acceptable definition of their efficiency of operation. The problem of the treatment of sewage, including strong industrial waste, has brought about the need for more definite consideration of the sewage strength elements and of yardsticks for measuring the load other than simple measurements of sewage volumes.

As the particular function of a trickling filter is to satisfy the oxygen demand of the sewage, it appears reasonable to measure the results of operation in terms of the reduction of the oxygen demand of the sewage by the filter. The biochemical oxygen demand test is becoming more generally used as an index of the efficiency of operation of trickling filters. The oxygen resources of the filter effluent also include dissolved oxygen and nitrates.

There are other tests, such as the determination of nitrogen elements and the change from the less stable to the more stable nitrogen compounds, which are useful in measuring the work done by the filtering material. The production of nitrates is a frequently used index of the operation of trickling filters and appears to be especially useful where the loading of the filter approaches the upper limit.

UNIT FILTER LOADINGS IMPORTANT

Passage of sewage through a filter bed requires a comparatively short interval during which the amount of organic matter in the sewage is reduced. The building up of the micro-biological growth on the filter media may be a matter of a considerable period. More extended study of the question of filter loadings will be required before the relationship between loadings and filter-material characteristics can be determined. Long-term and continuous records of filters operating close to their upper limit should give more valuable data from which to determine the relative effect of the various factors than isolated analyses or short-term records of filter operation, particularly if such filters are lightly loaded.

Many factors appear to influence the relation of loadings to filter efficiency. Dr. Hatfield has recently classified these factors under two groupings:

STRUCTURAL VARIABLES
- Depth of filter
- Type of underdrain and ventilation
- Length of dosing and resting periods
- Size, shape, and kind of filter material

PHYSIOLOGICAL VARIABLES
- Quantity of food for growth, or concentration
- Quality of food, or kind of organic matter
- Concentration of air, or ventilation
- Temperature of sewage
- Toxic chemicals in sewage

SELECTION OF GENERAL TYPE OF MATERIAL

Various materials have been used as media in sewage trickling filters. Many of the earlier filters, particularly in England, were constructed of clinkers, cinders, coke, or coal breeze. Excessive clogging and costs for cleaning have led to the use of better materials. The incomplete survey of trickling filters in the United States, made in 1925, gave certain data on quantities of various materials used as filter media. These data indicate that 83 per cent of the filter media for the plants surveyed was crushed rock of one type or another, 2 per cent gravel, 11 per cent slag, and most of the remaining 4 per cent cinders or coke. More complete data may modify these proportions somewhat, but they indicate the prevailing use of materials in the past.

Harder and more durable materials, such as crushed trap rock, quartzite, and certain granites, are more desirable from the viewpoint of durability. In the Central States area crushed limestone is the outstanding source of filter material. Certain filters have been constructed with the larger volume of material made up of the cheaper local stone, while the top 12 in. or so has been more expensive trap rock, granite, or quartzite. This plan has been used in Lexington, Ky., at the southerly plant in Cleveland, and elsewhere. In Lincoln, Nebr., quartzite was shipped from a distance and used in preference to the local limestone because of the inferior durability of the local stone.

Surface roughness undoubtedly has some bearing on the efficiency of operation of filter media. Excessively rough, honeycombed surfaces possibly tend to restrict unloading while unusually smooth surfaces might be detrimental by allowing too easy unloading. As yet, little has been done to determine the effect of surface roughness. Further, no standard or accepted method has been devised to measure surface roughness quantitatively, or the effect on surface area of shape irregularities.

The selection of the general type of material to be used must be determined for any given installation largely by judgment with reference to various local considerations. There are insufficient data to determine the relative merits of the various types of material, such as crushed stone, slag, gravel, and the like.

CARE IN SIZE AND GRADATION

There is difference of opinion among sanitary engineers as to the proper size of material. Smaller material is considered by some to be more efficient because of greater surface area. Others consider that the advantage of greater surface area is offset by the greater clogging troubles often experienced with small filtering media. It appears likely that the character of sewage applied has as much to do with filter clogging as the size of material. For example, the filters at Decatur clogged rather badly before the installation of pre-aeration, while no clogging has been experienced since then, even with an increase in volume of sewage applied. The Elgin filters, with relatively large, well graded, and well cleaned stone, have clogged badly during the past winter. On the other hand, the older Madison Burke plant filters, with rather small stone, have had little or no trouble with clogging.

Earlier sewage filters, particularly the English filters, included small-sized material. Certain recent practice has tended toward larger top stone. Usually the lower 6 in. or more of the filter bed is composed of fairly large stones, carefully placed in order to protect against the entrance of fine material into the underdrains.

When the minimum size of filtering material is specified, there is a tendency to place rather strict limitations on the allowable amount of material finer than this. At Akron 5 per cent was allowed to be less than the 1-in. size. At Hinsdale and at Jacksonville the amount of material less than 1 in. was limited to 3 per cent.

FILTER DEPTH IS PERTINENT

Consideration of materials for trickling filters must include some attention to the question of bed depth, particularly with reference to the relationship of this to loadings and the relative work done by the filter media at various depths.

Numerous experimental trickling filters have been operated for the purpose of determining the work done and the efficiency of media of various types. Unfortunately, some of these experimental plants were not operated for a sufficient length of time without interruption to establish definitely the interrelation of depth, efficiency of operation, and kind of filtering material.

Further investigations are required—and particularly a comparison of the operation results of existing installations over a period of years—before final and definite conclusions can be obtained as to the relative merits of deep versus shallow trickling filter beds.

It appears to be more or less generally accepted that trickling filters should be at least 5 to 6 ft. deep. Recently, a number have been installed with greater depths; thus the filters at Akron, Cleveland, Worcester, and Urbana-Champaign have been constructed with 10-ft. depths. The Baltimore, Bloomington, Ill., Elgin, Ill., and Fort Worth plants have depths ranging from 8 to 9 ft. Other recent filters have been constructed with 6-ft. depths.

The depth consideration will be particularly pertinent should more extensive investigation indicate that less durable and less expensive material can be used with success in the lower sections of the filter beds.

Consideration of the design of trickling filters, with reference to distribution of sewage over the filter and means for ventilation and underdrainage, are pertinent in connection with the consideration of filtering materials, for these factors influence very materially the efficiency of the filter units and accordingly must be taken into consideration when comparing the operation of one filter bed, with a given type of media, to another bed with a different kind. Unfortunately, many of the existing

trickling filter installations and some of the experimental units for which comparative data are available do not, or did not, have the three important factors of equal distribution, ventilation, and underdrainage.

SELECTING SOURCE OF MATERIAL

After the general type of filtering material has been chosen for a given installation, the next problem is the selection of a quarry or storage pile to be used as the source of the filtering material. The Committee on Filter Materials has given considerable attention to the question of tests for determining the comparative suitability of materials from various sources.

In the selection of limestone or other crushed stone products for use as filtering material, careful study should be made of the conditions at the quarry from which the material is to be obtained. Some quarries, particularly limestone quarries, include several layers of stone, some of which may be inferior for use in sewage filters. Thus a study should be made of the geological formations; the thickness of the several stone strata should be measured, particularly in the vicinity from which the supply is to be obtained; and samples should be selected for soundness and other physical tests. Attention should also be given to the crushing and screening facilities particularly with reference to the equipment available for separation of sizes less than the minimum size specified.

UNDERDRAINAGE SYSTEM AT DELAWARE, OHIO
Large, Hand-Placed Stones Keep Small Material out of Channels

SOUNDNESS TESTS

Probably a soundness test is the most practicable laboratory test for the comparison of the merits of two or more materials as to probable durability. Such tests for soundness have been made in a number of cases by subjecting the material to alternate cycles of artificial freezing and thawing. More recently a test has been developed by the Committee on Filter Materials and by others, comprising cycles of alternate soaking in a saturated sodium sulfate solution and drying in an oven. This method is described in detail by Dr. Kriege. The general idea of this test is not new. Much has been done, however, during the past year or more, to perfect the laboratory procedure of the test. This test is more severe than the freezing and thawing test, and thus is shorter. Twenty cycles of the sodium sulfate test appear to be equivalent to possibly as many as 250 cycles of artificial freezing and thawing.

Other determinations of the physical qualities of the several possible materials are frequently useful. These include the determination of specific gravity, of absorption and porosity, chemical analysis with reference to certain impurities, and micro-structural analyses by a qualified geologist.

Many of the existing trickling filters, particularly the smaller installations, contain an excessive amount of fine material, much of which was included in the stone as originally placed. Unless special care be taken with the screening and handling of the material during construction, it is likely that a greater quantity of fine material may be placed in the bed, or may become segregated in localized areas, than will result from deterioration over several years of exposure in operation.

Many of the stone quarries are now equipped, or may be equipped, with special screens of the horizontal vibratory type so that, by special rescreening, sewage filter material can be furnished at the quarry with a relatively high removal of fine materials.

In placing the material, care must also be exercised to prevent the segregation of the fines into localized areas. Thus if the material be transported by motor truck and placed by dumping directly into the filter bed, there is a tendency to segregate an objectionable amount of the fines in the upper parts of the filter bed. In the case of at least one of the large sewage filter installations constructed in recent years, the placing of material by belt conveyors has resulted in the segregating of fine material along the location of the conveyor to such an extent that noticeable difference in surface clogging has been observed in operation.

FILTER EFFICIENCY SHOULD BE DETERMINED

In the final analysis, design of sewage trickling filters with reference to the type, size, character, and amount of filter materials to be used must be based largely on results obtained in the actual operation of other trickling filter installations. Accordingly, it is pertinent in connection with filter materials to give consideration to methods of determining the efficiencies or actual operating results of existing installations. The difficulties encountered should be evaluated and their relationship to the filter material determined. The efficiency of operation is frequently measured in terms of the work done by the filter in reducing the oxygen demand of the sewage. Efficiency of operation can also be measured in terms of both nuisance and trouble produced in operation and in terms of operating costs.

NUISANCES HAMPER OPERATION

The more common difficulties experienced in the operation of trickling filters include clogging or ponding, fly nuisance, and sometimes odor nuisance. All of these usually relate to excessive growths on the filter stone and

are materially reduced, if not entirely eliminated, by keeping the filters clean. The facility with which this may be done quite likely relates directly to the character of the filter material. Undoubtedly some relationship exists between the character of the filter material which should be used and the character of the sewage applied.

Clogging or ponding of trickling filters has been the most common index to reduced filter efficiency for installations where analytical control is not available. Clogging develops where the voids between the filter material become filled to such an extent that sewage cannot readily pass through. Poor aeration of the filter bed and reduced efficiency result. Clogging or ponding may be due to excessive growths brought about by the character of the sewage; it may be due to improper unloading because of surface characteristics, or improper gradation of the filter material.

Difficulties with the psychoda fly, which are experienced in many trickling filters, may be related to the question of type of material, because fly troubles are worse where filters are hard to keep clean. Thus filter beds of material with considerable variations in size, or of material with very rough surfaces may have a greater tendency to clog up and thus provide more chance of development of fly troubles.

FILTER TROUBLES CAN BE CONTROLLED

Cleaning of filters and reduction of clogging is obtained by various means, the most common being to break up the surface growths by forking or harrowing, by cutting out a portion of the filters and allowing it to dry out, or by causing the growths to unload by flooding. In a number of instances, particularly at Schenectady, Lackawanna, Elgin, and elsewhere, serious clogging troubles have been remedied by hosing the filter, by using chlorine, or by both.

There have been a number of instances where it appears that sewage filter beds have been kept clean by insects, particularly the insect achorutes viaticus, sometimes called podura. These appear to live on the colloidal growth in the filter, and remove the slimy gelatinous substances which cause clogging or ponding troubles. They have been found in the Madison filters of the Burke plant, and I understand that Mr. Mackin has transplanted them to the filters of the New Madison Nine Springs Plant. Attempts have also been made to place them in the Elgin, Plainsville, Schenectady, and Baltimore filters. It is claimed that the filters which harbor achorutes viaticus are never troubled with the psychoda fly.

Operating Filters to Remove Organic Growths

By CHARLES C. HOMMON
ASSOCIATE MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
Sanitary Engineer in Charge of Sewage Treatment, Municipal Sewage Treatment Plant, Canton, Ohio

THE sanitary engineering profession has for many years recognized coarse grained filters as a means of treating municipal sewage. The very general use and relative cost of filters place them in a prominent place in the field of sewage treatment. It is not believed, however, that the filter has received the attention it deserves from the engineer and operator. The ability of the trickling filter to function, even under trying conditions, with at least a reasonable degree of efficiency has had a tendency to minimize constructive thought and efforts tending toward its further development and refinement.

Perhaps one of the most essential features in connection with the operation of the trickling filter is the removal of the organic deposits and growths that normally collect in such treatment devices. It is recognized by all concerned that every well clarified sewage carries solids, either in solution or suspension, in sufficient quantity eventually to fill the voids of the coarse grained aggregate unless some provision is made for their periodic removal. The long service records of some of the older sewage works give evidence that Nature has been kind and reasonably efficient in maintaining the filters in a usable condition, but it is doubtful if the self-cleansing process can be said to be entirely satisfactory.

STUDY OF TRICKLING FILTERS

During the year 1928, the writer had the opportunity to study some 60-odd sewage trickling filters scattered generally over the Central and Eastern States. The general physical condition of the filters was observed, and excessive amounts of organic deposit and growth were noted as an outstanding feature in a large number of the plants visited. Some few of the installations were comparatively free from deposits and growths and showed no tendency toward clogging, while others were quite dirty and showed evidence of clogging that ranged from slight surface pooling to practical submersion of large portions of the filter area. It was learned through questioning the respective plant operators, that nothing was being done to relieve the clogged condition except that, in one or two instances, probing of the aggregate was resorted to for temporary relief.

The removal of the solids contained in the applied sewage is a recognized feature of the trickling filter, and excessive deposits at periodic times, even to the extent of causing clogging, have been accepted as a logical occurrence. The natural agencies which usually accomplish the removal of the solids from the surfaces and voids of the coarse aggregate are but little understood, and the unloading periods are therefore beyond the control of the plant operator.

Sewage plant operators have experienced many anxious intervals, waiting for the periodic sloughing to offer relief for seriously clogged filters. The recognition that clogged filters are not only inefficient, but subject to complete failure if not relieved of their burden, and that relief measures are beyond the scope of the plant operator's activities has always been disquieting.

CONDITIONS IN CANTON

In connection with the operation of the Canton, Ohio, Sewage Works, some study has been given to the subject of controlling the deposition of solids and growths that normally collect in sewage trickling filters. The Canton filters were designed for a population of 135,000 persons, a filter load of 20,000 persons per acre, or 2,857 persons per acre-ft. The present connected population is esti-

mated at 100,000; therefore, the existing load is 15,000 persons per acre, 5,000 less than the designed load. The entire filter area is divided into four units of 1.7 acres each, which means that the resting of one unit places a load on the remaining three units of approximately 20,000 persons per acre. Under these conditions the filters have functioned with entire satisfaction, delivering at all times a stable effluent, as the figures in the following sentence will indicate. The bio-chemical oxygen demand of the filter influent and effluent for the year 1929 averaged 101 parts per million and 25 parts per million, respectively, which is equal to a reduction of approximately 75 per cent. The nitrate and dissolved oxygen content of the filter effluent averaged, for the year, better than 10.0 parts per million and 5.0 parts per million, respectively, and all of the putrescibility samples taken from filters which were in continuous service retained their color for ten days at 37 deg.

Surface Ponding on Sprinkling Filters at Elgin, Ill.
Condition on February 19, 1930, before Chlorination

DRYING TO CONTROL GROWTHS

At the time the work of controlling the deposits was started, the plant had been in continuous service about 18 months, at the end of which time the aggregate may be said to have been quite dirty, especially the top 6 or 8 in. During this period some slight sloughing had occurred, but it was not sufficient to prevent some evidence of surface ponding. The ponding, however, was largely due to algae growths on the surface of the aggregate.

It was originally intended to leave one unit of the filter undisturbed and in continuous service for control purposes, but this scheme had to be abandoned later in the year in order properly to control the development of the filter fly.

At the beginning, drying the filters for 24 hours every seven days was practiced for the purpose of killing and controlling the surface algae growths. This was found to be very effective not only in checking the growths, but also in causing them to slough from the surface of the slag aggregate; and all evidence of surface ponding disappeared with the first few dryings. The drying also appeared to affect the sewage organic deposit, causing it to become quite granular and brittle, and readily removable from the aggregate by the action of the spray. The 25-hour drying period was not sufficient, however, even during hot weather, to penetrate the aggregate to an appreciable depth, and the time interval of resting was lengthened to at least seven days, at the end of which time the top 12 in. of medium became quite dry and the deposits easily removed by the applied sewage.

By the middle of the summer of 1928, the development of the filter fly became so active that it was found necessary to flood all filters. Prior to the time of flooding, the upper areas of the slag medium appeared to be relatively clean. However, the first flooding water, when removed from the beds, carried an excessive amount of suspended matter, some catch samples running as high as 1,200 parts per million. The relatively high suspended-matter content of the flooding water was something of a surprise in view of the fact that the upper area of the filters was quite clean; but it is now believed that the flooding caused a dislodgment of solids from the aggregate deeper in the bed that had not been released by the drying action.

FILTER FLIES IN THE CANTON BEDS

The filter fly has, perhaps, bred more actively in the Canton beds than in any filter that has come under my observation. This excessive development is thought to be due to the complete absence of any pooling of sewage on the surface of the aggregate. This thought is expressed as the result of logical reasoning. Since flooding is destructive to the fly larvae as well as to the adult specimens, it is only fair to assume that there is a definite relationship between the fly development and the amount of water retained in the filtering material by the organic deposits. In other words, it appears that a clean aggregate is conducive to excessive breeding of the filter fly. Indirectly, the development and control of the filter fly may be considered of value since the

Elgin Sprinkling Filters after Chlorination
Condition on April 24, 1930, after a 25-day Continuous Application of Chlorine

flooding is of material assistance in keeping the aggregate free of organic deposits.

During the year 1929, systematic drying of the filters was practiced throughout the warmer months of the year, one unit being out of service at all times. The rest periods varied from 48 hours to ten days, depending on the weather conditions. The development of the filter fly was kept under complete control by flooding, which was done 11 times during the breeding season. In the late fall, numerous inspections of the aggregate at varying depths and locations showed the slag medium to be very free of organic deposits with the exception of small areas where excessive amounts of fine material prevailed.

IS DRYING OF FILTER SUCCESSFUL

Some attempts have been made to determine whether the present scheme of operation—one filter unit out of service at all times—will successfully handle the load for which the filters were designed. All of the results and observations tend strongly to indicate that no additional area will be required and that an even greater load may be conveniently handled.

In connection with the control of the deposits and growths and the consequent interruption of service, it was important to know whether or not the drying of the filter materially interfered with its nitrifying bacteriological activities. During my early training, I had been cautioned that filters should be kept in continuous service; that even short interruptions in service caused the microscopic plant and animal life to die out; and that this life would have to be reestablished upon resuming operation. This idea is more or less common among operators even now.

It was of interest to learn that the building up of nitrates continues during the drying period, presumably for an extended time. During the winter months of 1929 and 1930, it was necessary to interrupt the operation of the filters for a period of about 150 days to make some necessary repairs on the collecting gallery, and the analysis of the first effluent, after it was again placed in service, indicated a nitrate content of better than 75 parts per million. It is also noticed that the nitrates are materially higher than average immediately after a filter unit has been rested, thus indicating that the purification agencies are not detrimentally affected by the interruption of service.

POOLING CAN BE PREVENTED

Because of the complex nature of sewage and the many complicated reactions involved in the treatment process, one is not justified in drawing conclusions of general application as the result of experience gained through the functioning of one plant. Without making an attempt to draw such conclusions, it may be stated that the results secured at Canton in resting and flooding the filters have been distinctly beneficial to the condition and performance of the plant and have warranted the adoption of this procedure as a regular schedule of operation. The Canton results would also seem to indicate that the accumulation of deposits is within the control of the plant operator and that, therefore, the periodical surface pooling that often occurs, preceding natural sloughing, can be prevented. They also tend to indicate that the general efficiency of the plant is not impaired but, perhaps, increased.

The complete absence from worry concerning the possible clogging of the aggregate, the very satisfactory performance, and the pleasing appearance of the clean aggregate fully justify the additional care required in the operating program.

Selecting the Material to Prevent Clogging

By FRANK WOODBURY JONES

SANITARY CHEMIST, GEORGE B. GASCOIGNE, CONSULTING ENGINEER, CLEVELAND, OHIO

THE trickling filter followed by a settling tank is recognized in standard engineering practice as being an efficient and reliable means for the oxidation of dissolved organic substances in sewage. Although the fact is not generally realized, the suspended solids in the applied sewage are substantially reduced within the filter.

At the outset it would appear pertinent to define what is expected of an efficient trickling filter and what constitutes clogging. The efficiency of a trickling filter—and this includes the final settling tank—may be expressed in terms of the reduction effected in free ammonia, organic nitrogen, bio-chemical oxygen demand, and alkalinity. The degree to which the organic matter applied has been converted into nitrates is also important. A satisfactory final effluent should not contain over 20 to 35 parts per million of suspended solids, should have a bio-chemical oxygen demand under 25, and should show at least a 60 to 70 per cent reduction of the applied total nitrogen, of which 20 to 50 per cent should be oxidized to the nitrate form. The final effluent should be odorless and stable.

Clogging may be considered under the two headings of surface clogging and internal clogging. The latter includes a filling of the voids in the filtering material and stoppage of the underdrains.

FACTORS AFFECTING EFFICIENCY

The efficiency of a filter is dependent upon features of design to the extent that good design should provide for even distribution, free drainage, and effective aeration or ventilation. Depth seems to be largely a question of economics and individual opinion. Even distribution and free drainage are purely matters of hydraulics and correct design.

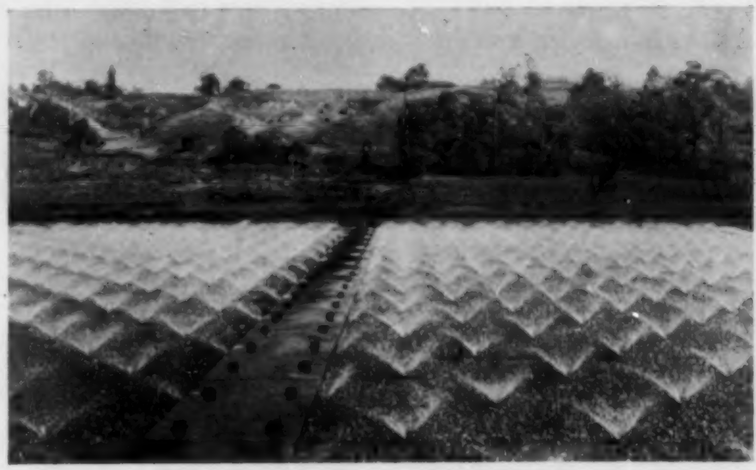
Although aeration is, at the outset, dependent on suitable design, it may be destroyed by clogging which may develop in the course of service. No trickling filter can operate efficiently unless there is an abundant air supply throughout its entire mass. This demands material of suitable size, cleanliness, and durability.

It may be stated, therefore, that a filter which is so designed and constructed that the sewage can be applied evenly over the surface, and flow away freely from the bottom after passing through media which are continuously well aerated, will produce efficient and satisfactory results when operated within reasonable limits of application.

CLOGGING GREATEST PROBLEM

The principal factor relating to effectiveness, which is subject to material variation incident to service, is that associated with aeration. Aside from overdosing, which in this discussion may be assumed to be within suitable limits, the most destructive agency to free ventilation is clogging. This suffocates the filter and depreciates its accomplishments.

As has been previously stated, clogging may occur at the surface or throughout the entire filter. Surface clogging is by far the more common. It may be caused by certain deleterious constituents in the sewage, inducing surface growths that seal the voids, cause pooling or ponding, and cut off the air supply. This is likely to occur on any filter irrespective of the size or type of material. Or, again, the preliminary treatment of the sewage may not have been sufficiently adequate to eliminate from the applied sewage a reasonable amount of the gross suspended solids. There may be occasional instances, also, where direct oxidation causes a precipitation of inert mineral material within the voids of the filter material, such as iron oxide from pickling liquors, an industrial waste frequently found in the sewage from manufacturing cities.



TRICKLING FILTERS IN OPERATION
Cleveland Southerly Sewage Treatment Works

FILTER MEDIA IMPORTANT

Clogging may also be attributable to conditions occurring in the filtering media. Suitable filtering material is perhaps the most important part of the whole structure. However uniform the distribution, or however effective the underdrains, no filter can produce efficient results unless the media are well aerated and active. For continuous efficiency, the filtering material must be continuously covered with biological growths under aerobic conditions. To this end, the material must be clean and of suitable size when placed. It must be durable, to maintain its original size, and it must be of such surface texture as to permit a ready sloughing off of the stored solids. Clogging or consolidation of the filtering media will prevent proper functioning and consequently impair efficiency.

The filtering material may be responsible for clogging in two ways: first, by disintegration which cuts down the effective volume of voids; and second, by surface conditions of the individual particles which will hold back solids and prevent unloading. The proper size to use is still a mooted question. It is a generally accepted fact that the smaller material will effect a greater degree of purification for a time at least, in that more surface area is available; but, on the other hand, small material clogs more easily and more often. It is agreed, however, that the material should be as uniform in size as possible, whether that size be specified at 1, 2, or 3 in. Uniform size provides the greatest percentage of voids, and voids are essential.

Cleanliness of the material when placed is of prime importance. Pockets of fines soon consolidate and constitute local areas impervious to the passage of sewage, and these areas consequently become "sick" and ineffective. It is obvious that, if the original filter material is reduced in size by disintegration caused by chemical action, weathering, or freezing and thawing, the size of the voids will be reduced, as will also the percentage of open spaces. Where this occurs, the filter bed is readily subject to clogging and consolidation. It may be concluded, therefore, that the filtering medium should be permanent and subject to no change in form or condition throughout its period of service.

The relative advantages of smooth and rough surfaces have not been definitely established. Furthermore, there is no workable standard by which relative roughness may be measured. There seems, however, to be a hesitancy against using a material which is too smooth, such as gravel, or one which is too rough, such as the more porous slags. This question demands investigation, since the data now available do not appear adequate to form definite conclusions as to just what function the relative roughness of the particles performs in maintaining filter efficiency.

OPERATION MAY RUIN FILTER

Clogging and falling off in efficiencies are not wholly attributable to characteristics of the filtering material or other features of plant design. Improper rates of application and methods of operation may ruin a good filter, or again, careful application and operation may produce fair results from a filter of indifferent design and construction.

In conclusion, we are of the opinion that, under suitable rates of application, a trickling filter will accomplish satisfactory results, providing features of plant design pertaining to distribution, drainage, and aeration are effectively incorporated. The filtering material must be of suitable, uniform size and durability and of such surface texture as to secure, on the one hand, adherence of gelatinous films and to permit, on the other, a free sloughing off of the stored solids. Disintegration and consolidation of the filtering material will induce clogging and impaired efficiency.

It is true also that, where changes have taken place in the filtering material, corrective measures usually employed to remedy clogging are not so readily applicable. To be effective, the well designed filter must be

maintained in the same state, year in and year out, under continuous service. The favorable service history of several of the well known trickling filters of this country demonstrates that this is possible.

An Accelerated Soundness Test

By DR. HERBERT F. KRIEGE
THE FRANCE STONE COMPANY LABORATORIES, TOLEDO

THE last few decades have seen tremendous interest in the development of test procedures for all types of building materials. We have come to recognize the importance of a physical or chemical test which can be reproduced with a fair degree of accuracy, and may give strong indication, if not positive proof, of certain desirable qualities in the material. Tests for durability have been stressed as much as any because the permanence of structures depends largely upon the weather-resisting properties of the materials employed. In sewage disposal practice the question of durability is of prime importance, since the mineral aggregates used in the concrete surrounding the filter bed and as filter-bed media are exposed to unusually severe conditions of weathering.

While special emphasis, within recent years, has been placed on a suitable durability test, it is of interest to note that our widely discussed sodium sulfate test for soundness harks back to 1828, being in part the procedure employed by Brard—later modified by D'Héricart and de Thury. This early procedure consisted of boiling the samples in a saturated solution of sodium sulfate for one-half hour in order to get complete saturation, cooling under fresh solution for several hours, and then hanging the specimens suspended by threads for a 12-hr. crystallization period in a dark room.

In this discussion, which will be concerned chiefly with the sodum sulfate soundness test, I have chosen to include concrete aggregate, both fine and coarse, and filter-bed sands, as well as the coarser mineral aggregates commonly employed as sewage disposal media. Every sanitary engineer will recognize the reason for so doing, since it is a fairly common experience to find the concrete retaining walls about a filter bed in a worse state of deterioration than the exposed mineral aggregates in the bed itself. Sanitary engineers are concerned with the problems of durability of concrete. Likewise, the weathering conditions applying to the coarser mineral aggregates must also apply, to a greater or less extent, to the filter bed supplied with finer aggregate.

TESTING FACTORS LONG OVERLOOKED

In spite of the fact that our present information is not very complete as to the relationship between sodium sulfate soundness and actual durability of the material under field conditions, it seems that we are long overdue in appreciating the importance of three factors: (1) the source, selection, and size of the sample tested; (2) the fundamentals involved in the sodium sulfate crystallization processes; (3) the proper interpretation of the results of the test.

The most satisfactory sampling is certainly that of the material after it has been manufactured for use; the product which is bought and sold. Tests on original deposits from which a commodity is manufactured can never be as truly representative as those on the material actually to be used as filter-bed medium or concrete aggregate.

TEMPERATURE OF SOLUTION IMPORTANT

Regarding the temperature of saturation of the original solution I recommend that the solution be saturated at a temperature not less than 5 deg. fahr. above the highest temperature likely to persist during the immersion period. Thus, if the temperature of the room or the bath in which the sodium sulfate containers are kept is apt to attain 80 deg. fahr., the temperature of the saturation of the sodium sulfate solution should be

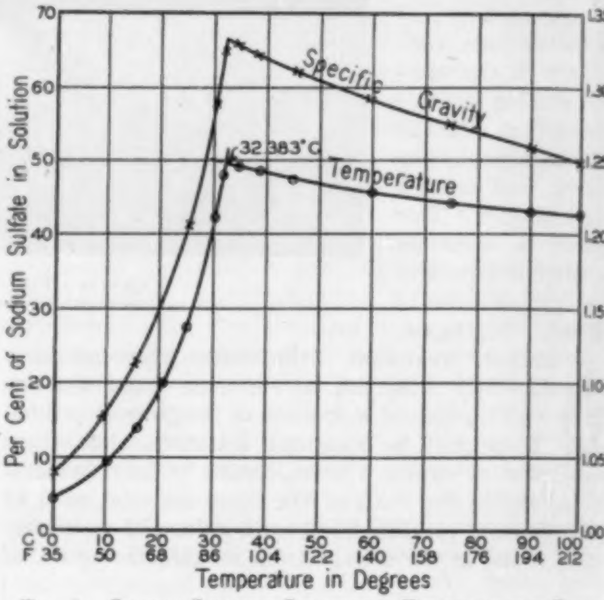


FIG. 1. SODIUM SULFATE SOLUBILITY-TEMPERATURE CURVE

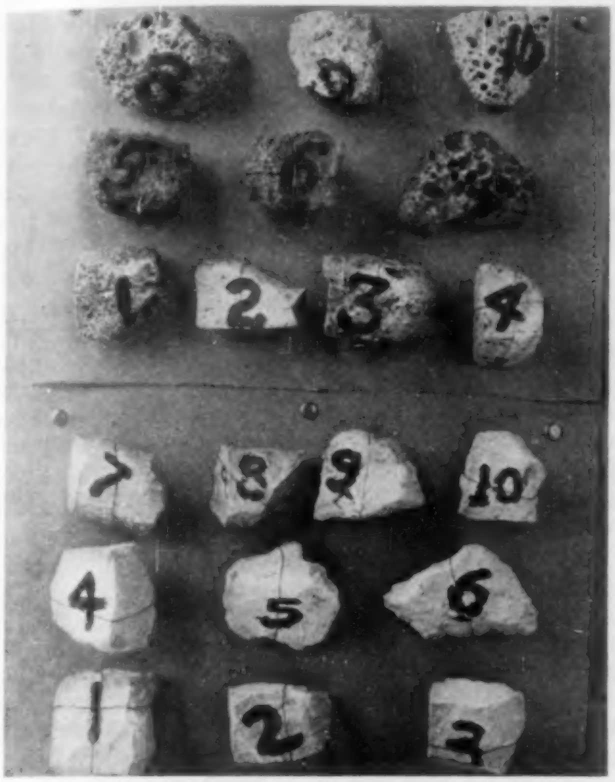
at least 85 deg. fahr. This will assure at all times the presence of excess crystals in the solution and the state of saturation. This state is vital to the uniformity of results of this soundness test.

Some data are available concerning the effect of temperature of saturation and the presence of excess crystals, which can best be discussed with the aid of the solubility-temperature chart, Fig. 1. The ordinates indicate the percentages of anhydrous salt Na_2SO_4 in the solution. Specific gravity values are also shown. Temperatures are shown along the horizontal axis, in both centigrade and fahrenheit units. It is evident that the steepest portion of the solubility curve occurs in that zone of temperatures commonly encountered in fluctuating room temperatures, namely, 68–90 deg. fahr. This means that slight variations in temperature will cause rather large variations in the amount of salt held in solution. Thus, between 68 deg. fahr. and 86 deg. fahr. the strength of the solution changes from 20 per cent to over 41 per cent. The reason for more crystallization in the containers and in the immersed sample pores at one temperature than at another should be very apparent from this solubility chart.

Maintaining a constant temperature in the immersing solution will tend to decrease the severity of the test, since it prevents the increase of the crystal growth in the pores

of the specimen due to temperature changes alone. If we desire to maintain a constant temperature, it is obviously necessary to reduce the temperature of the test specimens after drying to approximately the temperature of the solution.

If we decide to permit the solution temperature to vary with room temperatures, we must expect some variation in results on the same material tested at different times of the year and in different laboratories. These variations probably will not be as serious as are the misinterpretations likely to occur from our present method of expressing the results of the test, namely, "marked checking, cracking, and disintegration."



Slag and Limestone before Sodium Sulfate Test

Slag and Limestone after 20 Cycles of Sodium Sulfate Test

DEFINITE VARIATION DESIRABLE

It seems a desirable addition to our present test procedure to cause a definite temperature variation to occur during each cycle. This can be effected without undue expenditure of time or money by immersing the containers of the sodium sulfate solution in a larger volume of water whose temperature is regulated by proper means. A forced change in temperature of 5 or 10 deg. cent. would materially increase the destructive action of the soundness test and for this reason is desirable.

Beginning with the second immersion, various disrupting forces are being set up within the pores of the specimen. With each immersion, the amount of fresh solution gaining access to the pores is reduced by the presence of accumulating residues of salt. Provided the pore volume does not change, due to disruption of the specimen, the gains in residual salt diminish relatively with each successive immersion.

EFFECTS OF COOLING

Let us now turn to the consideration of another effect of temperature on the sodium sulfate soundness test. Previously, we mentioned the fact that any drop in temperature below that at which the solution was saturated adds crystals to the growth already begun within the pores of an immersed sample. While this statement may appear obviously correct to many, it will be worth while to consider the extent of this additional crystal growth and corresponding disrupting force.

The normal room temperature fluctuations of solutions saturated at higher temperatures may be almost as effective as a cycle in which the immersing solution is saturated at and maintained at a lower temperature. Unquestionably, then, we must take into account not only the number of degrees of change but also the temperature at which the changes occur. This should explain the observation that practically all operators of this test have noted, namely, that after a considerable drop in temperature in the solutions, much more distress is registered by the immersed specimens.

UNIFORM RESULTS OBTAINED

In spite of the many variable conditions permitted in the sodium sulfate test, as commonly run, it is worthy of note that different laboratories can duplicate one another's results to a satisfactory extent when the same conditions are maintained. Thirteen laboratories cooperated to conduct the test as outlined by the Committee on Filtering Materials to show different degrees of disintegration during the 20 cycles. The eight or nine laboratories which followed the suggested outline in letter and principle, in all cases classified properly

the ten kinds of slag and stone into sound, unsound, and questionable groups. This is rather remarkable when it is remembered that only two specimens of each kind of material were given each laboratory. There is every reason to believe that larger samples would have reduced the variations between the laboratories still more. The sodium sulfate test is as reliable when the important conditions are controlled as are the usual tests for abrasion, hardness, and toughness.

NEGLECTED PHASES OF PROCEDURE

Perhaps an apology is necessary in trying to present a new outline for a test procedure for the sodium sulfate soundness test. It has become popular to suggest slight variations in the test procedure as run by other laboratories. The unfortunate fact is that too frequently variations have been suggested without regard to certain fundamental considerations, such as have been discussed previously in this paper. In view of the fact that an uncertainty exists in the minds of many testing engineers regarding other phases of the problem of testing for durability, a method of procedure covering certain neglected phases is outlined in the following paragraphs.

If the material tested is for sewage disposal media, at least 20 pieces shall be taken for the soundness test. If the material is to be used for concrete aggregate, the sample shall consist of at least 50 pieces between 1 in. and 2 in. in diameter, or of 2,500 grams of material caught between 1 in. and $^1/_2$ in. square-opening sieves. If the material to be used is filter-bed sand or concrete fine aggregate, the sample shall consist of 1,000 grams carefully screened between any desired mesh, such as 4–8, or 14–28. All samples shall be secured by quartering or dividing to the desired members or amounts, thus eliminating as much as possible the personal element from the selection of the samples.

The solution of sodium sulfate shall be prepared in the following manner. Anhydrous sodium sulfate, Na_2SO_4, or the decahydrate, $Na_2SO_4.10H_2O$ shall be added to hot water at the rate of 400 grams or 900 grams per liter respectively, or, in round numbers, 0.9 lb. or 2 lb. per quart of water. The solution shall be heated $^1/_2$ hr. to 85–90 deg. fahr., with frequent stirrings to prevent caking in the bottom and to effect solution quickly. After this, it shall be set aside for at least 12 hr. before use.

During the preparation and use of this solution there should be present at all times excess crystals of the salt (decahydrate) to insure saturation. Suitable receptacles for the individual sample solutions are 1-gal. earthenware crocks. These may be covered easily, have poor thermal conductivity, are not attacked by the solution, and are readily cleaned.

SPECIMENS CAREFULLY EXAMINED

The selected sample is examined for fractures and cracked pieces. Any loose fragments should be removed before the test is begun. The sample is then plainly marked and thoroughly dried for at least 4 hr. at 105 deg. cent., carefully weighed, and then immersed in the solution. It is often helpful to weigh individual specimens separately when about 20 are taken for the sample. The samples should be completely immersed in the solution for 19 hr., with the temperature being maintained between 80 and 85 deg. fahr.

At the end of each soaking period, the specimen (of the larger sizes) shall be examined individually, with great care, for any sign of disintegration, such as cracking, checking, splitting, or crumbling. The portions which can be removed with the fingers shall be taken off, weighed, set aside for later consideration, and calculated to per cent loss for that cycle. A sample which breaks into three or more pieces shall be considered as failing and shall be removed from the test, weighed, and considered lost. The number of pieces affected during the cycle shall also be noted. Smaller aggregates and sands shall be examined visually after each cycle for apparent distress. After each five cycles the samples shall be dried, sieved, and the per cent of material which then passes the lower size sieve determined.

After examination, the specimen shall be placed in a previously heated drying oven and be maintained for 4 hr. at a temperature of approximately 105 deg. cent. Then the sample shall be cooled for 1 hr. before being immersed in the sodium sulfate solution. One cycle shall consist of 4 hr. drying, 1 hr. cooling and 19 hr. soaking, including the time for an examination of the material. The test shall be run for 5 cycles on concrete aggregates, and for 20 cycles on material for sewage disposal filtering medium.

INTERPRETING RESULTS OF TEST

An individual specimen breaking into three or more portions (each portion being more than 10 per cent of the original weight of the piece) or losing more than 20 per cent of its weight by chipping or flaking, shall be considered to have failed in the test. A sample having 20 per cent or more of its pieces failing shall be considered unsound. Likewise, when 20 per cent or more, by weight, of chips and flakes are formed during the test passing the $^1/_2$-in. sieve (square openings), this shall constitute unsoundness in the sample. A sample shall be classed of "doubtful soundness," when 15 to 20 per cent of its pieces fail, or if 15 to 20 per cent of its weight is lost in chips and fragments. Such material shall be tested again for durability. If it is classed as "doubtful" the second time, this behavior shall be interpreted to indicate the unsoundness of the sample.

Smaller aggregates and sands shall be classed as unsound when more than 20 per cent of their weight has been sufficiently reduced in size during the test to pass the sieve used as the lower limit for the original sample. At the end of the test, the remaining portion of the sample shall be freed from Na_2SO_4 by a repeated boiling and soaking process, the wash water being renewed four or five times. After drying and weighing, the total loss during the test is determined by the difference between the original and the final weights of the sample. Materials not failing in the preceding classifications shall be considered sound.

In conclusion, let me state that a questionnaire was recently sent to 99 engineers of prominence in the fields of highway, sanitary, and testing engineering. Whenever possible, I have taken freely from the information gathered and, as a result, much of this discussion and suggested procedure is a consensus of opinion.

Metropolitan Park Improvements Pay

Cleveland's Experience in Developing Its Parks

By William A. Stinchcomb

Member American Society of Civil Engineers
Director Cleveland Metropolitan Park Board

Development of park systems on a regional scale may be said to have passed its experimental stage. Many communities—in fact, all the larger metropolitan districts—have long been active in such development, either as one large entity embracing a wide area, or as a group of several smaller political subdivisions.

Cleveland is a case in point. It has struggled with the problem of its Metropolitan Park System, has made some headway, and is still progressing. The public demand for parks and recreation centers is ever increasing. Although Cleveland's experience is perhaps not exceptional, it is interesting to all engineers and city planners engaged in this type of work. Mr. Stinchcomb read his paper before the City Planning Division of the Society at the Cleveland Convention, July 10, 1930.

We have long recognized the importance of parks and playgrounds in the city plan. No engineer, today, would consider his city plan complete unless it contained a well defined park and playground system. Yet out-of-door recreational needs cannot be satisfied by the city parks and playgrounds alone; and so there has come an increasing demand for larger public parks and reservations. Witness the increased popularity of the national parks.

The administrators of our national forests now realize that the recreational value of those forests probably exceeds their value as a source of timber supply. They have made and are continuing to make provision for the further use and enjoyment of these forests for recreational purposes. State governments are also recognizing the need served by State parks, and are setting aside areas for them. In addition to the recreational needs served by these parks, great metropolitan centers throughout the country are realizing that, through the advent of the automobile and the good road, the out-of-door recreational requirements of the urban population can best be served by the development of systems of metropolitan parks. As a result, elaborate park systems in the vicinity of great urban populations have been developed.

Other factors have contributed to the demand for these larger park units, among them the improved economic status of the people. Because of the changing conditions under which we live, it has become increasingly essential that society shall provide these recreational areas. The so-called "machine age" tends to concentrate populations in urban territory, forcing people to live in congested conditions where they are deprived of the opportunities for out-of-door recreation and exercise which they enjoyed when most homes were single family units surrounded by a yard. It is reported that 90 per cent of the people in New York live in apartments; that 70 per cent of those in Chicago are similarly housed; and that the percentage is constantly increasing in all of the large cities.

Then, too, this machine age has brought with it different conditions of work. The industrial output of one individual has been multiplied many times, and the result extends from the humblest worker in the shop to the executive in the office surrounded by the many devices that record the thoughts of his brain. Hours of labor have been shortened, and while nervous energy has been increasingly consumed and exhausted, leisure time has increased.

Nature's Gifts Improved

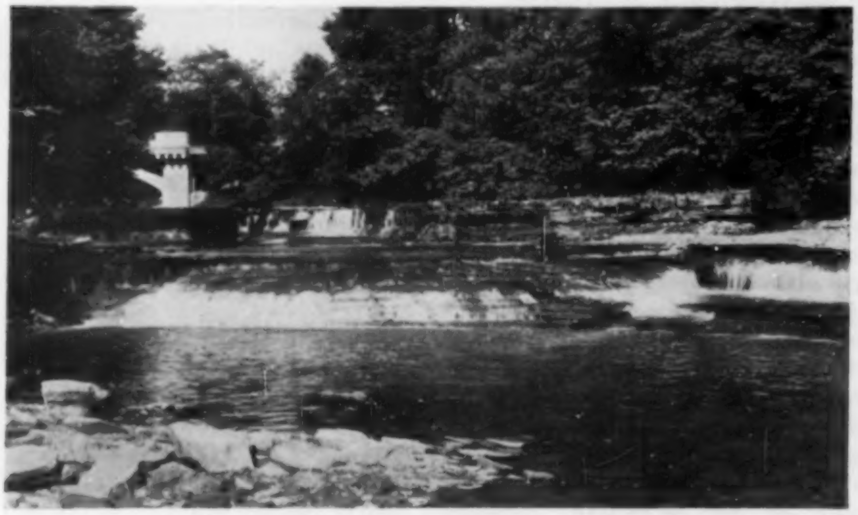
Throughout the Metropolitan District of Cleveland these changed social and economic conditions are now being met, and to an increasing extent will continue to be met through the areas and the facilities afforded by the Cleveland Metropolitan Park System. In laying out and establishing this system, every attempt has been made to take advantage of the topography.

A visitor arriving in Cleveland, by one of the major trunk-line railroads or principal highways, is probably aware that the city and its environs are for the most part situated upon a plateau, a broad band of which lies along the lake front at an elevation of approximately 80 or 90 ft. above lake level. The areas to the south extend to a higher elevation, particularly in the section that embraces Cleveland Heights, Shaker Heights, Warrensville, Mayfield, and the territory extending in an eastern and southern direction. This plateau borders the valley of the Cuyahoga River. Within the limits of the city, the Cuyahoga River Valley has been taken over for industrial purposes and is the site of numerous steel plants, lumbering and other building industries, and various kinds of manufacturing.

Furthermore, the metropolitan region of which Cleveland is the center is practically surrounded by areas of broken land; to the west by the valley of the Rocky River; to the east by the Chagrin River Valley, which, like Rocky River, flows into Lake Erie; and to the south, by Tinker's Creek and Chippewa Creek, tributaries of the Cuyahoga River.

In laying out the Cleveland Metropolitan Park System, the fundamental rule of regional planning—that "uses," resulting in the greatest economic and social good to an area, should be prescribed—has been adopted. Generally, therefore, the land within the Metropolitan Park System is that which, by reason of location or topography, has little value for residential or agricultural purposes, and is so situated, with reference to the location of lines of railway transportation, as not to be required in any future expansion of the city's industrial areas. In addition, it is so located as to form a half circle of parks and parkways around Cleveland and its environs. This half circle, broken only by the lake on the north, extends to distances varying from 10 to 20 miles from the heart of the city itself.

Other connections have been made with the park system by means of highways radiating from the city like the spokes of a wheel. These extend through the Big Creek Parkway to the southwest and to the Shaker Extension on the east. In addition, about a half mile of lake frontage has been secured, to the west of the city, in the Village of Bay. In the course of future development, it is hoped that similar areas may be secured to the east in order that the recreational and scenic possibilities of lake frontage may be more adequately realized by this community.



BRIDGE OVER FALLS IN SOUTH CHAGRIN RESERVATION

As now conceived, the Cleveland Metropolitan Park System will embrace approximately 15,000 acres of land. There is very little doubt, however, that our conception of what should be included within this park system will grow as the city and its suburbs increase in size and population. Approximately 10,000 acres have, to date, been secured for this purpose, including land for nine principal parks and parkways which vary in size from the Huntington Park, containing 100 acres of land, to the Rocky River Parkway of over 3,000 acres of land.

OHIO PARK LAWS

In Ohio, the Park District Law is somewhat peculiar in that it sets up a code of laws for the operation of these districts but provides that their creation shall be left to the people of the community. The preliminary steps are taken either by petition of electors to the Probate Court, or by appropriate resolution of some one of the political subdivisions making up the district.

After publication of the receipt of such resolution or petition, the court holds a hearing and listens to arguments for and against the creation of the park district. If the decision is favorable, the district is created, and a board of park commissioners is appointed by the court. This board consists of three members, who serve overlapping terms of three years without compensation but under bond.

One provision of the law stipulates that the district, as originally set up, must lie wholly within one county and cannot divide any municipality, village, or township. Subsequent annexations may be made of territory outside of the county in which the original district was formed, such annexations being made by petition to the probate court of the county in which the territory proposed for annexation is situated. Then, after a hearing and upon order of the court, annexation is made if the court has found such annexation to be conducive to the public welfare.

FUNDS RAISED BY TAXATION

Financing of the Park District is through a general levy, not exceeding 0.1 mill, imposed by the budget commission of the county or counties making up the district. Other levies may be voted by the electorate of the district, but not more than 0.1 mill can be submitted at any election. The Cleveland Metropolitan Park District raises annually nearly $800,000 by these means. The park district has such other revenues as it may obtain through the operation of its facilities: fees from golf courses, concessions, and rents. In the case of the Cleveland Metropolitan Park District, these revenues, other than taxes, amount to approximately $100,000 a year, and represent about 75 per cent of the annual operating costs of the park system for administration, maintenance, and policing. As further developments take place, expenses will increase, but revenues should also increase. While no attempt has been made to take from the public any costs or fees except where a peculiar and special service is being rendered, nevertheless the time will probably come when operation costs can be paid from the revenues and receipts outside of taxes, and for that purpose no direct charge will be made upon the taxpayers.

MAKING USE OF ONE OF THE MANY PARK STOVES
Concrete stoves are now being replaced with cast-iron models at all 25 of the picnic grounds

Those who are familiar with tax rates usually levied for park purposes will realize that the rates prescribed by law for park districts in Ohio are very meager. The rate of 0.1 mill is indeed very small; and except for the rather large tax duplicate—the Cleveland Metropolitan Park District includes all of Cuyahoga County, with an

assessed value of $3,000,000,000—the progress which has been made in the acquisition and improvement of this system would not have been possible.

CONSTRUCTIVE PROGRESS MADE

Acquisitions of land actually began in an intensive way less than ten years ago, and up until about a year ago the major activities of the board have been directed toward acquiring those areas necessary for the system before the development of suburban lands in the vicinity should so increase the price of the rough areas as to place them beyond the possibility of acquisition with the funds at its disposal. At the same time, the board, recognizing the necessity for maintaining constant public approval of its undertaking, has been making inexpensive improvements, such as the construction of bridle paths, hiking trails, nature trails, picnic grounds, and secondary or graveled drives, thus making accessible and usable much of the area obtained. In addition, the board operates two public golf courses with net profits of approximately $25,000 a year, after taking out all expenses for maintenance and management, and interest on costs of land and construction.

Throughout, the board has attempted to stress the cultural opportunities of the parks, which not only foster an appreciation of the beauty of nature but also offer many opportunities for the study of natural science.

BATHERS AT HUNTINGTON BEACH
Stone jetty construction forms sand beaches

POINTS OF INTEREST LABELED

In cooperation with the Cleveland Museum of Natural History, five nature trails have been established; and while we have not yet attempted to maintain personally conducted tours under nature guides, the Cleveland trails are unique in that they tell their own story in a most interesting manner. No attempt has been made to label anything merely for the sake of giving it a name, but something of interest has been told of every object named. The scientist might criticize our trails, but the average individual goes away with an increased interest in the objects which he has seen. Then, too, we have attempted to make the exposed cliffs of various stratification of clays, shale conglomerates, and sand strata tell the story of the creation and the building of the earth. They reveal the meaning of the fossil remains which have been found 60 ft. below the present elevation of the top land—remains of sea monsters which swam over this area 400,000,000 years or more ago, before the mountains were pushed up along the Eastern Seaboard.

RUSTIC SHELTER HOUSE IN BRECKSVILLE PICNIC GROUNDS

One of the great problems constantly before the board is the maintenance of park streams in a condition appropriate to park surroundings. Lands which have been taken over very largely for park purposes are those which in the ordinary course of events, in the extension and development of urban areas, would be considered waste lands. The banks of the valleys had been dumping grounds and were disfigured with rubbish and debris accumulated through the years, and the streams had become fouled with the sewage of the surrounding watershed. It is a rather sad comment on our present-day civilization that we tend to spoil in this way these park areas, which in themselves are a great natural resource.

It has not been difficult to eradicate the dumps; that has been merely a matter of policing. But it has been a continual fight to bring about cooperation among the many political subdivisions existing within one watershed, so as to study their drainage and sewage problems as a whole, and to work out methods of collection and disposal. Progress has been made, but eternal vigilance is necessary in order to maintain it.

TO STUDY SANITARY CONDITIONS

The board has resisted the placing of sewage disposal plants in the Rocky River Valley until a time when a comprehensive study of the sanitary requirements can be made. It is hoped that one plant may be constructed for the complete purification of sewage. Treatment will probably be by the activated sludge process; and during the summer, or bathing season, the effluent will be

chlorinated. Thus, the establishment of numerous small and independent plants will be prevented.

Bacteriological tests show that the water in the places where bathing is permitted in the Rocky River Valley is much safer than it is along the Cleveland lake front in Edgewater or Gordon Park, and practically as pure as the lake water near the west county line at Bay Village or Huntington Park.

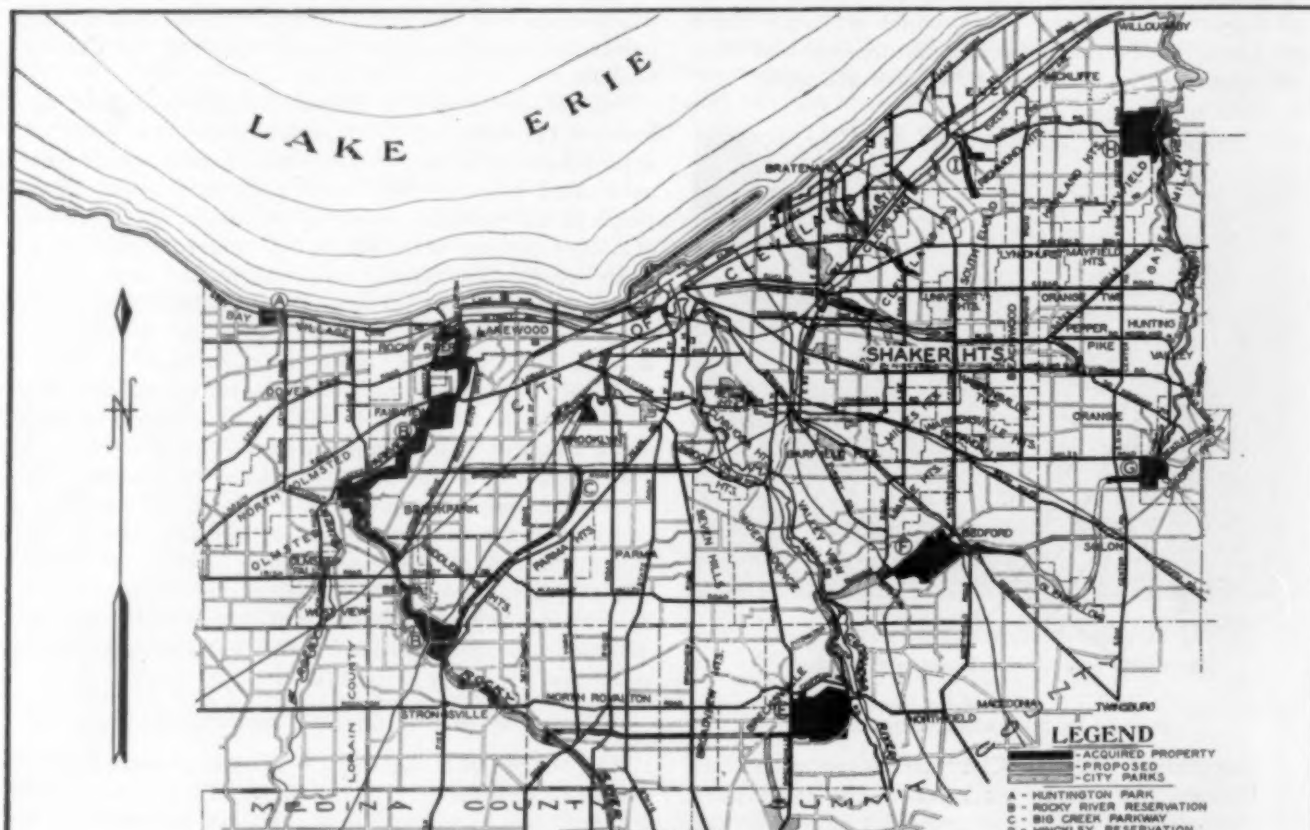
PARK IMPROVEMENT AN ECONOMIC ASSET

A well planned park system, following the fundamental rules of regional planning, has a definite effect on the economic values of the community. That is the history of every community which has established such a park system. The areas in the immediate park vicinity, which in the natural course of events would be the least valuable for residential purposes, become the most valuable. The real estate values within the influence of these park areas are thus accelerated and far exceed the normal increase of the values in the rest of the community.

HILLARD ROAD BRIDGE
Cleveland Metropolitan Park System

Control of the development of private property that borders on park property is accomplished by securing easement clauses in the deeds of purchase of park property, which run in perpetuity. One of the greatest examples of this kind of high-class residential development within the United States is the Cleveland Heights and the Shaker Heights territory. Of course all the credit cannot go to the parks, but without question the extensions of the park system leading into Cleveland Heights and Shaker Heights established the character of these developments in spite of the fact that it took intelligent planning and development, transportation, sanitation, and many other things to create those beautiful residential areas. Although the Metropolitan Park System is new, we have seen land valued at $400 an acre adjacent to these park areas increase in price to $75 a foot of frontage overlooking the parkways.

Such a park system becomes, then, a most essential part of the regional plan of the community, and the park layout tends to create such a plan in that it fixes the location of the most desirable residential areas. It also precludes the possibility of industrial and commercial development intruding upon those areas naturally adapted for other purposes.



Making the Most of the City Plat

Suggestions for a Manual on Subdivision of Urban Land

By Rolland S. Wallis
Member American Society of Civil Engineers
Field Secretary, Regional Planning Federation,
Philadelphia Tri-State District

Principles are more important than facts, especially in a preliminary study on which later progress is to be built. Translating this into terms of the proposed manuals on city planning, Mr. Wallis believes that the basis of the entire study is first to be determined. The details may then be expanded in due course.

Taking the fundamental question of subdivision of urban land as applying quite generally to city planning problems, it is probable that the basic principles then to be determined will be found useful in many other instances. In expressing such basic ideas as broadly as possible, many fundamental questions naturally arise. To these, Mr. Wallis offers tentative answers, leaving it to others to point further application. This paper was presented before the City Planning Division at the Society's Cleveland Convention, July 10, 1930.

The query, "What is the relation of land subdivision to the city plan?," introduces an academic topic, although it is fundamental in connection with the preparation of the proposed manual on land subdivision. The practical purpose of subdividing land is to get it into salable units of convenient size, suited to its probable intended use, and to give access to each parcel or lot by means of public streets. In the usual course of events, the physical structure of each community grows by successive accretions of newly platted areas, each with its blocks and streets.

As time goes on, buildings erected in these subdivisions may be replaced with more up-to-date structures, but the streets tend to remain unchanged because the cost and difficulties of alteration increase so rapidly with passing years. In spite of this permanence of street platting and the far-reaching social and economic advantages of scientific design as applied to the platting of land, the division of undeveloped urban areas into building lots has, in most communities, gone forward in an illogical fashion—somewhat like putting together the irregular pieces of a picture puzzle without paying any attention to the formation of a complete picture.

Platting of land subdivisions should be regarded as an important phase of urban planning. The design of subdivision plans is, in fact, the detailing of a portion of the city plan of a community, the subdivision plat bearing to the city plan much the same relation that the design of one part of a machine bears to the general design of the whole. Land platting without the guidance of a comprehensive city plan is merely piecemeal planning; and to see the jumbled results of such individualism in detail planning, we have only to examine the street plans of the older portions of almost any American city.

Where a community has the good fortune to have the guidance of an official city plan, which comprehensively defines a system of thoroughfares adequate to furnish proper communication throughout the city, the layout of any subordinate area into blocks and lots satisfying community needs and suited to the character of the neighborhood, becomes a matter of ingenuity in applying modern principles of subdivision platting. Each subdivision plat is a detailed section of the plan of the city and, if the city structure is to be satisfactory, the plat should not only be well designed in itself, but it should fit into the comprehensive plan in proper relation to the remainder of the community.

It follows naturally that subdivisions which provide systematically for the thoroughfares and open spaces required by the community must have the guidance of a city plan. This means that the city plan should precede subdivision planning if the best results are to be obtained.

Is There Professional Need for Such a Manual?

The professional need for a manual setting forth the accepted principles and criteria of land-subdivision design will vary with each engineer, according to the nature and extent of his practice. Those who have been active in the field of city planning will have little need for such a compilation as an aid to design, but they will probably look upon it with favor as being an authoritative statement of the present status of this branch of design.

To the engineer in whose practice city planning or land subdivision has not received much emphasis, such a manual would be of considerable suggestive value in connection with occasional work of this character which he might be called upon to do. It would also be an addition to his store of information on this class of planning. The setting down of the principles of land subdivision would benefit the profession by concentrating the thought of those active in this field upon the clear statement of the fundamentals upon which their designing is based.

To students of civil engineering, and particularly to those who wish to ground themselves in the principles of city planning, a manual should prove of great value. Books have been written about city planning, but few have been written in such a way as to serve satisfactorily as textbooks in engineering courses, particularly on the technic of subdivision design. While the existing books and current literature serve admirably for supplementary reading, there is a real need for a concise statement covering the principles and criteria on which good practice in this field is now based.

Is There Public Need for This Manual?

The interest of the general public in city planning has grown until it has become a dependable factor in civic

affairs; and the popular acceptance of scientific platting design as exemplified by various developments of residential land—particularly those planned on a community or "neighborhood" basis—seems amply to justify the contention that the general public will welcome with open arms any developer who can give the urban dweller more attractive living conditions at a price he can afford to pay. To this problem of land subdivision, so long stereotyped in its application that the general public expects little else, the engineering designer who is able to mix successfully his calculations of costs with considerations of beauty and livability can bring new and promising solutions.

The owner of urban land which is in the path of an expanding community and has become too valuable to be used longer for agricultural purposes, is interested in learning what can be done with it. His own ideas of its possibilities are usually limited to the type of land subdivision to be found in the community in which he lives, and his chief concern is to get the greatest possible number of salable lots laid off on the tract. There may be, however, a city planning commission in his town, and its interest in carrying out the city plan then prompts a study of the possibilities of the tract. As is often the case, the owner is surprised and delighted to learn that, by making a few changes in his plat, he will be able to capitalize on the natural beauty and other advantages of the site so as to get a better plat and to realize more from the sale of his land.

RADBURN, NEAR PATERSON, N.J.
Constructive Planning to Meet Modern Motor Needs

THE QUESTION OF CONTENTS

While the proposed manual on subdivision practice could hardly be placed in the hands of all owners of land about to be subdivided, there are various possibilities that such a publication would be of benefit to many an owner. The surveyor or engineer whom the owner employs to plat and stake out his land may, through study of such a publication, have come to look upon land platting as something more than a routine job of surveying and may advise certain changes which would take advantage of some of the natural assets of the tract. Or perhaps the city engineer, as ex-officio member of the planning commission or as adviser to the city council, may, from a broadened viewpoint on the subject of land-subdivision design, suggest the observance of some principle which would result in a better plat. Every good plat benefits not only the owner, the real estate operator, and the public official, but also the general public interested in the development of the community.

The manuals issued by the Society to date are too few in number to establish definitely the character of this type of publication, but a criterion has been established by an article in PROCEEDINGS (Part II, March 1929), that is quoted as follows:

" 'Manuals,' as they have heretofore been called, are a new publication appearing from time to time as a series of 'separates' and having the character of a ready reference volume on matters of every-day concern. . . .

"Manuals are not papers and are not reports—these are incorporated in PROCEEDINGS. Manuals are thoroughly digested expositions of matter not hitherto collated . . ."

The general object of a manual on the subdivision of urban land should be, it seems, to set forth clearly and concisely the generally accepted principles of modern scientific planning to the end that an improved technic in subdivision design may be stimulated and a wider popular appreciation gained of the need, advantages, and possibilities of the skillful application of such planning principles.

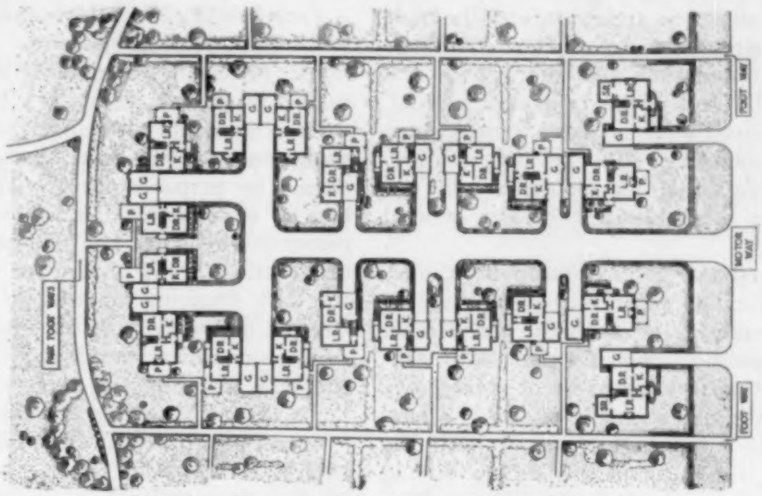
While the proportion of urban areas given over to residential purposes is so much greater than the proportion devoted to commercial or industrial uses that discussions on the subject of land subdivision are usually confined to land platting for residential use, it is suggested that the proposed manual cover all phases of urban platting. Although in existing communities there may be but few chances to lay out new industrial areas, and even fewer to modify the plan of central business districts, there do occur occasional opportunities for replatting portions of existing districts and for planning new communities. Particularly pertinent, in view of the modern tendency to set up neighborhood shopping centers by zoning, would be a statement of the fundamental principles which should control this phase of platting design.

In its content, a manual on subdivision of land might be made to simulate a typical set of municipal rules, standards, or minimum requirements, an attempt being made to set up a reasonable, though necessarily arbitrary set of requirements, in the hope that such a code might be found generally applicable to the conditions encountered in municipalities throughout the country. The objection to this is that, if so-called "standards" are desired, such a procedure would be merely a compromise.

Would it not be simpler and far less controversial to compile a tabulation of the requirements of the numerous municipalities throughout this country, which are attempting to control the platting of land within their

areas, either with or without the guidance of city plans? Such compilations, however, have already been presented, a recent notable example being the publication by T. K. Hubbard and H. V. Hubbard of *Our Cities Today and Tomorrow*. This work is the result of a field investigation made, in 1928–1929, under a grant from the Milton Fund for Research by Harvard University. Such a manual, then, would merely present material previously collated and, therefore, would not satisfy the Society's criterion just quoted.

Another plan, more difficult but more worth while, would be to formulate a statement of the principles and criteria underlying the scientific design of modern subdivisions. This would mean turning away from absolute standards, minimum requirements, and the arbitrary rules now effectively stifling initiative in the layout of subdivisions in various communities, in favor of a set of sound principles, coupled with discussions of the limitations which have been set up by modern practice.



UNIT IN A RADBURN DEVELOPMENT SUPER-BLOCK
Interior of Each Block Developed as a Park

Such a presentation would constitute a rational basis for design. Supplemented by graphical illustrations of the principles presented, and by actual examples illustrative of modern practice in this field, it would constitute a textbook on the fundamentals of subdivision design. A publication of this sort would not be a mere rule book; it would place before the designer the various arguments for and against each tendency in design, leaving to his ingenuity the proper balancing of the various considerations of good practice and the conditions imposed by the problem before him. For his convenience, a comparative statement of the requirements of various cities might be added, either as comment on each item discussed, or as an appendix to the text of the manual.

There seems to be a tendency in the minds of some to confuse the rules of platting regulations with the principles of design, although most of the regulations imposed by municipalities contain but little matter of suggestive value to a designer.

The scientific planning of land subdivisions cannot be expected to result from the familiar combination of a landowner ignorant of the possibilities of skillful planning as applied to his tract of ground, and a city council which does not have the time or the technical ability to pass upon the merits, or lack of merit, of subdivision plats submitted for approval. The basis for the approval of such plats is usually a set of so-called "standards"—arbitrary criteria which demand that all streets, blocks, and lots shall be alike, regardless of their locations, the topography of the tract, or their functions. This procedure, which has become so common to our municipalities, is a striking example of the blind leading the blind.

Standardization cannot successfully be substituted for design. The best thing that rules for land subdivision can do is to prevent some of the more obvious errors, leaving to the designer full opportunity to introduce better planning into his plats—subject, of course, to approval by a properly constituted planning authority, working under a comprehensive city plan for the community. The proposed manual, therefore, might well contain a model ordinance, universally applicable but less arbitrary than is typical of existing ordinances. Such ordinances should control, but not standardize, design. Legal regulation, generally speaking, is designed for the few who offend ignorantly or maliciously, rather than for the much larger group whose normal behavior requires no such regulation. The law is inclined to set up minimum requirements rather than to paint a picture of the ideal.

PREPARATION A PRACTICAL PROBLEM

The rapidity with which the science of urban planning has advanced is perhaps the principal reason why some city planning practitioners question the advisability of attempting to issue a manual on city planning. It is probable, however, that there would be less objection to the publication of a manual on the subject of land subdivision.

The popular interest in the better planning of our cities, which has arisen during the last two decades, has demanded of city planners the development of certain principles of design. Many of these are generally accepted, but it is recognized that there are others which are frankly in the controversial stage and are employed by planners on a somewhat experimental basis, if at all. There are being continually presented ideas or theories which have not been thoroughly investigated, or actually used.

To the practitioners who contend that the principles on which city planning is based are too intangible for statement in definite and concise form, answer must be made that such a condition would scarcely appear to measure up to the confidence which the layman has been led to place in the merits of scientific planning for the future physical growth of our cities. The call for a clear statement of the principles underlying such planning may, therefore, be regarded as something of a challenge to the civil engineer.

In taking the position that it is both desirable and practicable to set down the principles which are guiding good planning practice of the present day, and particu-

larly those of subdivision design, it is freely conceded that decisions on controversial matters would have to be left to the personal judgment of each designer, and that a periodic revision of any manual that might be issued would probably prove necessary in order to keep it in line with the current developments in this field or design.

SHOULD OTHER ORGANIZATIONS COOPERATE?

Land subdivision, in its various phases, is of professional concern to a number of groups other than civil engineers, such as the landscape architects and the realtors. It might be desirable, therefore, to secure the advantages of their cooperation and support in the preparation and distribution of the proposed manual. Not only should the contributions from these groups assist materially in rounding out the presentation, but their varying professional viewpoints would undoubtedly constitute a desirable test of the general soundness of the work.

From both professional and public viewpoints, the effectiveness and the general acceptance of such a manual on land subdivision would depend upon the professional authority behind the publication. To the realtor, for example, a manual of this sort would be of greater significance if it carried the endorsement of the National Real Estate Board. It is believed, moreover, that the principles set forth by a manual on this subject should be such as would pass muster with those of the realtors who have subjected the problem of real-estate development to a thorough analysis.

DESIRABILITY OF SERIAL PUBLICATION

A manual on the subdivision of urban land might be published as one division or chapter of a manual which would cover, in comprehensive fashion, the whole subject of city planning, or it might be issued separately as one of a series of such manuals which, taken collectively, would constitute, when finished, an authoritative presentation of the principles underlying the practice of city planning in all its phases.

It would seem expedient to issue separately each manual of such a series as soon as it is prepared and approved for publication by the Division and the Society, rather than to defer publication until all phases of the subject have been covered. If this plan should be followed, however, it is apparent that some inconsistencies and overlappings would probably creep into the separate presentations as prepared by different sub-committees. The manuals first issued would have to be revised periodically, and all manuals so prepared and issued would have to be revised and edited prior to any publication as a comprehensive manual on city planning. Certainly the problem of preparing a manual on city planning should not be approached with the thought that there will be no further developments in the technic of this class of planning.

CONCLUSION

While not committed to the belief that the other phases of city planning cannot be similarly treated, I feel that it would be both expedient and practicable to issue a manual on land subdivision at the present time, either as one of a projected series on city planning or as an independent publication.

Division Accepts Report of Wide-Awake Committee

The Chairman of the Division's Committee on Manuals, H. E. Young, M. Am. Soc. C.E., prepared a report on *A Manual of City Planning; Scope and Procedure*, which, due to the unavoidable absence of its author, was read by Eugene Taylor, Esq., of the City Planning Commission of Chicago.

Very briefly, Mr. Young outlined the proposed work of his committee as concerned with three primary questions: (1) Shall a manual be prepared? (2) If so, how shall it be produced? and (3) What shall it contain?

His comments subsequently were based on the assumption that "the right kind of a city planning manual should be prepared for the information, guidance, and benefit of city officials, engineers, and others." He recommended that the manual be produced with the cooperation of the American City Planning Institute, the City Planning Foundation of America, and the National Conference on City Planning. The membership of these organizations, Mr. Young pointed out, includes the best talent in the professions of law, architecture, landscape architecture, economics, and engineering.

In answer to his third question as to what the manual should contain, Mr. Young suggested that each member of the committee submit independent reports outlining the scope of the manual, with the idea that all of the individual reports could later be collated. In accordance with this suggestion, Mr. Young submitted a tentative outline of a manual consisting of five major parts.

Section 1; Functional. All forms of transportation, communication, and distribution, including steam railroads and railroad terminals; electric railroads and terminals; rapid transit, subways and elevateds; surface street cars and bus lines; grade crossings; air transit facilities and terminals; waterways, docks, and harbors; streets, highways, boulevards, and parkways; arterial highways and major thoroughfares; trucking and commercial routes; by-pass routes; heavy traffic streets; express streets; residential and local streets; city, county, state, and national routes; through routes, stop streets; gaps and street extensions; alleys; garage and filling-station facilities; super-highways, types and widths of pavements and walks; street grade separations; street furnishings; street lighting; billboards and overhanging signs; street encroachments and obstructions; traffic regulations; signs and signals; public utilities.

Section 2; Recreational. Parks, playgrounds, forest preserves, bathing beaches, golf and tennis facilities.

Section 3; Administrative. Public buildings, civic centers, neighborhood centers, fire and police stations, libraries and museums, aquariums, planetariums, stadiums, and civic art.

Section 4; Educational. Public lecture and concert facilities, aesthetics and psychology of city planning.

Section 5; Program. City planning projects; economics, legal and financial; budgeting and scheduling of projects according to need and financial possibilities; building development; zoning; set-back lines; housing; slum removal; blighted districts; relationship between residential, commercial, and industrial districts; regional planning; state plannning; and national planning.

HINTS THAT HELP

Today's Expedient—Tomorrow's Rule

The minutiae of every-day experience comprise a store of knowledge upon which we depend for growth as individuals and as a profession. This department, designed to contain practical or ingenious suggestions from young and old alike, should afford general pleasure not unmixed with profit.

Simple Model Checks Indeterminate Structure

By J. Charles Rathbun
Member American Society of Civil Engineers
Professor of Civil Engineering, Antioch College, Ohio

One simple method of checking influence lines, as computed for an indeterminate structure, is by means of a model. Often, the apparatus and material are very inexpensive, and skilled labor is not needed, so the check can be performed without a great deal of trouble and expense.

The experiment which is here described was designed and executed as part of the civil engineering course at Antioch College to make the students see more clearly the function performed by the sway braces, laterals, and other members of the bridge as well as to impress upon them the fact that a deflection curve is an influence line.

The bridge selected was a two-span continuous highway structure 800 ft. long. The student who performed the experiment spent his cooperative periods on the construction of this bridge in a subordinate capacity, so that he was able to coordinate his practical and theoretical work to a considerable extent.

BUILDING THE MODEL

From the stress sheet, the size of members, length between centers, and influence line for an end-abutment reaction were obtained. The model was built on a profile scale of 1 in. = 20 ft., and on a cross-section scale of 1 sq. in. = 2,000 sq. in. of material in the member itself. These scales were taken arbitrarily and bear no relationship to each other.

In building the model, celluloid taken from a sheet 0.03 in. thick was used. With a sharp, pointed knife, strips 0.08 in. wide were cut, and members were built up from these. Where necessary to get the proper area, smaller strips were used, and the members were built from two or more strips as required. In assembling the strips to form the trusses, the top and bottom chords were first secured by means of common pins stuck into a board along both edges, following the outline of the truss drawn on the board.

CEMENTING THE PARTS

After having been built to the required area and lined up, the upper edge was brushed with a one-to-two mixture of emil acitate and acitone. The liquid was readily drawn between the strips by capillarity where it dissolved the celluloid before evaporating, thus cementing the strips. Without unpinning the chords from the board, the strips that formed the webbing were fitted into position. Where they did not fit well, due to inaccurate cutting as to length and bevel, the resulting imperfections were rectified by filling the cavity with a thick mixture of dissolved celluloid.

After a few days in the heated laboratory, it was found that several of the web members had warped. These had to be removed, the strips separated and straightened in hot water, and the member replaced or a new member put in. After the two trusses were finished, they were clamped on either side of a length of timber planed to the proper width, and the laterals and sway bracings placed in position.

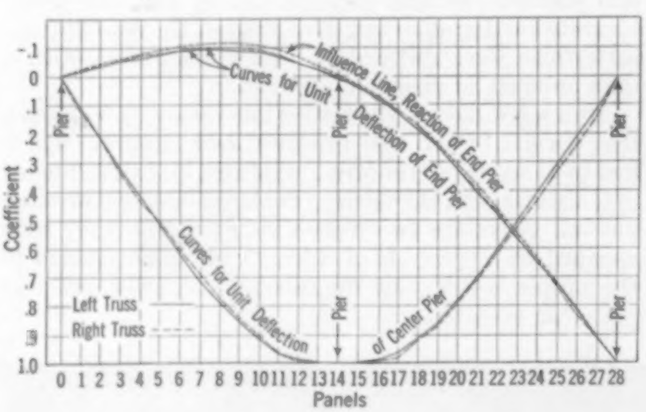
Celluloid Model of Highway Bridge with 800-Ft. Span

When the model was completed it was mounted on a rigid wooden structure, as shown in the photograph, with one fixed and two rocker shoes. Phonograph needles were used for pins. In the model, the fixed shoe was placed on one end.

Celluloid has not proven ideal as a material for this work because of its tendency to warp. When the model was taken into the sun for photographing, it warped rather badly. However, the warped members can easily be straightened by heat or removed and replaced so that this fault is not a serious one. As a matter of fact, warping causes but little trouble when the model is used indoors.

DEFLECTION CURVES PLOTTED

In making the deflection curve, an Ames dial, reading to 0.001 in., was mounted on a ring stand and placed at one of the panels. The shoe was removed at the pier for which the influence line, or deflection curve, was to be drawn. Shims about $^1/_4$ in. thick were inserted between the bridge and the pier, and weight of sufficient magnitude to insure deflection was placed on the truss over the shims. After a reading was taken on the dial, the shims were removed and a second reading taken after the truss had deflected to its new bearing. The difference between these readings was the deflection of the panel, and this divided by the thickness of the shims was the deflection due to unit deflection at the piers.



DEFLECTION CURVES AND INFLUENCE LINE

As this computation was made by slide rule, there was no advantage in having the shims exactly $^1/_4$ in. thick. Actually, they were 0.249 in. From a series of such observations the deflection curves for each truss and pier were plotted.

COMPARING RESULTS WITH INFLUENCE LINE

The accompanying diagram shows the resulting deflection curves for the center and end piers, and also the influence line for the end pier as taken from the stress sheet. Theoretically, the three curves for the end pier should coincide. Probably the deflection of the center shoe and experimental errors are responsible for some of the deviation. Even so, the agreement in position affords a substantial check on the equality of the values.

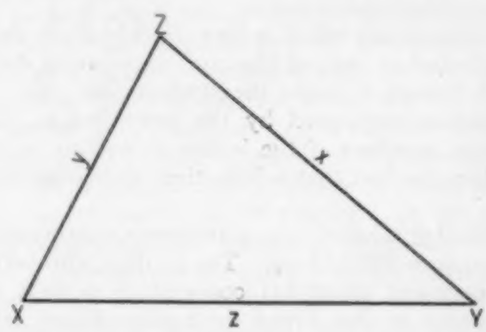
The Three-Point Problem Simplified

By JAMES B. GOODWIN

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
ENGINEER, HYDRO-ELECTRIC POWER COMMISSION, ONTARIO, CANADA

RECENTLY there have appeared several solutions for what is known as the three-point problem. This problem arises very often, particularly in precise surveys, and a simple solution becomes of value. In some of the solutions, use has been made of the trial and error method, with adjustments to meet the requirements, and in others to a semi-graphical method giving approximate values which are adjusted mathematically.

Becoming interested in an attempt to simplify the mathematics of the problem, I have derived the following two solutions which appear to materially shorten the labor of computation.



The problem may be stated as follows: in the triangle XYZ given two angles $X + Y = B$ and $\dfrac{\sin X}{\sin Y} = a$.

FIRST SOLUTION

The relation given in the statement of the problem is general, and will apply to any oblique triangle.

In the triangle XYZ, $X + Y = B = 180° - Z$ and, by sine formula, $\dfrac{\sin X}{\sin Y} = \dfrac{x}{y} = a$, or $x = ay$.

In any triangle, by tangent formula,

$$\frac{\tan\left(\dfrac{X-Y}{2}\right)}{\tan\left(\dfrac{X+Y}{2}\right)} = \frac{x-y}{x+y}$$

$$\text{or, } \tan\left(\frac{X-Y}{2}\right) = \left(\frac{x-y}{x+y}\right)\tan\left(\frac{X+Y}{2}\right)$$

By substituting ay for x, and B for $X + Y$,

$$\tan\left(\frac{X-Y}{2}\right) = \left(\frac{ay-y}{ay+y}\right)\tan\left(\frac{B}{2}\right)$$

$$= \left(\frac{a-1}{a+1}\right)\tan\left(\frac{B}{2}\right),$$

from which $\dfrac{X-Y}{2}$ may be calculated.

Then, since $X + Y = 180° - Z = B$,

$$X = \frac{X - Y}{2} + \frac{X + Y}{2}, \text{ and } Y = B - X.$$

If a is less than 1, it indicates that X is less than Y, and the equation may be written:

$$\tan\left(\frac{Y - X}{2}\right) = \left(\frac{1 - a}{1 + a}\right) \tan\left(\frac{B}{2}\right)$$

SECOND SOLUTION

Since $\dfrac{\sin X}{\sin Y} = a$, $\sin X = a \sin Y$; and

since $X + Y = B$, $X = B - Y$. It follows that $\sin X = \sin (B - Y) = \sin B \cos Y - \cos B \sin Y$.

Substituting $a \sin Y$ for $\sin X$,

$$a \sin Y = \sin B \cos Y - \cos B \sin Y,$$

$$\begin{aligned} \text{or, } \sin B \cos Y &= a \sin Y + \cos B \sin Y \\ &= \sin Y (a + \cos B) \\ \text{and } \sin B &= \frac{\sin Y}{\cos Y} (a + \cos B) \\ &= \tan Y (a + \cos B) \end{aligned}$$

Therefore $\tan Y = \dfrac{\sin B}{a + \cos B}$.

This latter solution appears more easily applied, and may be preferred to the first. In either case, the angles X and Y being determined, the lengths x and y may be readily calculated by the usual sine formula.

Our Readers Say—

More Concerning Our Professional Background

To the Editor: In reading W. E. Wickenden's address before the Society at the Cleveland Convention, published in Part 2 of Proceedings for September 1930, I was a little surprised that Mr. Wickenden did not give a closer account of our early New England engineers, particularly after his experience in Boston. I had the pleasure of intimate personal acquaintance with most of these men, excepting Loami Baldwin and Uriah Boyden.

My ideal for nearly 60 years has been Charles Storrow, of Boston, for many years the best educated engineer in America, who lived to the great age of 97. He often told me of his early experiences and of how his zeal in relating what he had seen in France of the Lawrence brothers led to the founding of the Lawrence Scientific School.

Storrow graduated first in his class at Harvard 101 years ago, and after browsing a few months in the greatest engineering library in America in those days, that of Loami Baldwin, decided to go to France to study engineering because there were no adequate schools in America. Through the friendly influence of Lafayette, he attended the École des Ponts et Chausées. Just as he completed his three years there, Stevenson was achieving success in the building of the Manchester and Liverpool Railroad, so young Storrow went there and took service under him. He then came back to Boston and became Chief Engineer and Manager of the first railroad in New England, the Boston and Lowell. Soon afterward he wrote the first treatise on public water supply in the English language, quoting largely from the recent hydraulic works of d'Aubisson and d'Prony, a most remarkable little book.

It was Storrow who first recognized the ability of James B. Francis and, by offering him the position of chief engineer for building water power and planning the city of Lawrence, stimulated the Locks and Canals Directors of Lowell to give Francis proper scope for research.

I have touched a little on the work of some of these men in the introduction to my book of a year ago, *Hydraulic Laboratory Practice*. Fifty years ago the center of hydraulic engineering in America was in eastern Massachusetts, all of which in a way was the lengthened shadow of Storrow.

John R. Freeman, M. Am. Soc. C.E.
Consulting Hydraulic Engineer

Providence, R.I.
September 20, 1930

Professional Standing of Junior Members

Dear Sir: The proposed amendment to the constitution favors examination of applicants for membership in the Junior grade when these applicants have not graduated from an engineering school of recognized standing. If this amendment is adopted, the professional standing of a Junior, who is not a graduate but who has successfully passed the examination set by the American Society of Civil Engineers, should be in all respects equal to that of a Junior with a degree in civil engineering.

If this is the case, and if the Society is recognized by the Government of the United States, should not a member of the Society, whether he has an engineering degree or not, be regarded by the Government as a qualified engineer, and therefore be eligible for Government employment?

It would seem from the Civil Service educational requisites that the Government does not regard any man as a qualified civil engineer unless he has attended a university—in some examinations a degree being required, and in others at least two years' university attendance, before he may be considered for appointment. Apparently, this is the stand of the Civil Service Examiners regarding both permanent and temporary appointments.

I believe that membership in the Society should testify as to a man's engineering qualifications, irrespective of the manner in which he has obtained his education, and be sufficient to satisfy the Civil Service as to his eligibility for appointment as a Civil Engineer.

C. C. Allen, Assoc. M. Am. Soc. C.E.

Box 642
Ely, Nevada
September 13, 1930

Qualifying Tests for Arc Welders Essential

SIR: In the paper appearing in the October number of CIVIL ENGINEERING, Professor McKibben has presented the facts concerning the use of arc welding in building construction in a clear and comprehensive manner. He makes no extravagant claims for the process, but shows it to be reliable and convenient, offering many advantages over ordinary riveting. He also recommends working stresses that have proved to be safe in practice.

The personal equation of the welder must always be carefully considered, and the qualifying tests required by Professor McKibben furnish means which make it possible to eliminate poor or unskilled workmen. The qualifying tests suggested will safeguard any job against poor work by the welders, provided, of course, that the apparatus is kept in proper condition under the care of an experienced man. The art of welding in the field is comparatively new, and it is very probable that developments in the near future will tend to increase its adaptability and reduce its cost.

H. W. HAYWARD, M. Am. Soc. C.E.
Consulting Engineer

Cambridge, Mass.
October 7, 1930

Medievalism Prevents Engineering Development in China

DEAR SIR: Religion and politics, factors predominant through the ages, are the two principal deterrents to progress in China today. When the fertility and ability of the Chinese brain is understood and appreciated, it is seen to equal the most advanced races of mankind. The failure of such fertile minds to produce a civilization equal to, or exceeding that of Europe and America in material comforts and the safety of life can be understood only through an appreciation of the religious principles and political turmoil which have controlled and continue to control Chinese life.

Since the continuity and purpose of life are both uncertain, the desirability of creating material things to increase the comfort and security of living is not axiomatic in the Chinese mind. The Chinese joins with the philosopher in saying that vanity, vanity, all is vanity. Of what advantage is it to drain land so that two grains of wheat will grow where one grew before? The result will be an increase in population, an increased demand for wheat, and a struggle for existence on the part of more people. The purpose of many a Chinaman is so to live that there may be sufficient funds to raise a family to worship his spirit, to secure a restful burying place, and to provide a funeral which will assure eternal joy to his spirit. In China the dead are happier and more revered than the living. Why then waste the efforts and the energies of the living to bridge a river or to stop a flood when the river can be crossed in a boat, and the sun will dry up the flood?

Sanitation is almost unknown in most Chinese cities. Western principles of sanitation are not practiced. The existence of immense and crowded cities without public water supplies or sewerage systems would seem impossible, yet the Chinese are successful in maintaining life under such conditions. The same fine minds, the same ability to accomplish great things exist among the Chinese today as existed among the Europeans in the Middle Ages. They are inhibited by a political condition which none is able to better in spite of the fact that all are aware of its undesirability. When a strong leader or a general change of mind appears, it is probable that Western ideals in standards of living will so affect the Chinese that the long-heralded awakening will come, and China will take its place among the leading nations of the world. No signs of this awakening are yet upon the horizon.

I should like to join with Mr. Lane in voicing an appeal for a sympathetic understanding and appreciation of the qualities of our brother engineers in China. An appreciation of their sterling qualities and abilities, and an understanding of the insurmountable religious and political obstacles against which they must labor will strengthen the proverbial bond of friendship between China and the United States.

H. E. BABBITT, M. Am. Soc. C.E.
Professor of Sanitary Engineering, University of Illinois

Urbana, Illinois
October 6, 1930

Pittsburgh Engineers Also Assist Chamber of Commerce

THE EDITOR: Referring to the interesting account of the organization of an Engineering Council in the Chamber of Commerce of Savannah, Ga., in June of the current year, it may be of interest to know that a similar Engineering Council was organized in the Chamber of Commerce of Pittsburgh on November 12, 1926, and has been actively engaged since that date in the work of advising the Board of Directors of the Chamber of Commerce as to the views of its engineer members on community problems coming before the Board, and having an engineering aspect.

Among these problems have been included the support of appropriations of the City of Pittsburgh and the County of Allegheny for the completion of a topographic survey of the Pittsburgh district; cooperation with the United States Department of Commerce and with manufacturers and distributors in the standardization of structural steel sections; cooperation with the State Department of Labor and Industry in the development of regulations affecting excavation work; investigation of the proposed Clarion River Dam and of the effect of its construction upon the Pittsburgh district; study of legislation introduced into the Pennsylvania Legislature relating to stream pollution, water conservation and utilization; studies of the effect of the proposed Metropolitan Plan of government for the Pittsburgh district upon the organization of public works construction and upon the position of the engineering organizations of the local municipalities; and cooperation with the Industrial Expansion Committee of the Chamber of Commerce in investigating opportunities for bringing in new industries.

In addition, the Engineers Council has been able to supply speakers on engineering subjects from time to time for membership meetings of the entire Chamber of Commerce.

These facts are reported, not for the purpose of detracting from the credit due to the engineers of Savannah, who should indeed be congratulated upon their initiative and public spirit, but only because it is believed that they may be of some interest to your readers.

MAURICE R. SCHARFF, M. Am. Soc. C.E.
Chairman, Engineers Council, Chamber of Commerce of Pittsburgh

Pittsburgh, Pa.
October 7, 1930

SOCIETY AFFAIRS

Official and Semi-Official

New Idea Functions Splendidly

FOR the first time, at Cleveland last July, a quarterly meeting of the Society was conducted on the newly adopted regional basis. Perhaps the details of the plan can best be explained in terms of the actual procedure.

A year previously, at Milwaukee, the Directors and the Vice-President resident in the region—largely Zone III—together with representatives of the Local Sections in that region, had met to discuss the selection of a place for the 1930 Summer Meeting. Of the various cities suggested, Cleveland appeared to be the proper choice and was therefore officially designated.

The actual preparation for, and conduct of the meeting itself were also in the hands of this regional committee, although business details and specific plans had to be supplied by the members resident in Cleveland. In the same way, the Technical Divisions adapted their sessions to the regional interests. The point is that the responsibility for the meeting rested largely on all the Society members and the various units within the region considered.

If the plan may be judged from its results at Cleveland, it has amply justified itself. To pick out any element of that meeting for special notice would be unfair discrimination against the rest of the program. There was, however, one unique feature which the committee approached with considerable diffidence and followed with trepidation. Reference is made to the plan of holding a general excursion in the morning of one of the days followed by a technical session in the afternoon. In spite of the arduous trip on Thursday morning to Akron, Ohio, to visit the Goodyear Zeppelin Airship Dock, the attendance at the afternoon sessions, much to the surprise of some, was apparently not in the least diminished. Speaking for the meeting as a whole, the members and their guests seemed enthusiastic about the entire program, the technical sessions, technical excursions, and social events alike.

Both logical and gratifying to those in charge of the Cleveland Meeting is the plan of including a résumé of all its technical sessions in the November issue of CIVIL ENGINEERING. In this way it becomes possible to present quickly to every member, including those not present at the meetings, the gist of the many good things made available at that time. In the face of inescapable space limitations, it seemed far better to present the meat of all the subjects—although at the expense of some condensation—than to omit any of the papers in order that others might be given in full.

Some of the papers, such as those on the Cleveland Union Terminal, the Shaker Heights Development, and the Akron Airship Dock, had the advantage of being augmented by a visual inspection. The same is true also, although perhaps to a lesser extent, of the Cleveland Park System. Discussion of the Coal Dock and Car Dumper Plant at Toledo and the extensive consideration of sanitary engineering matters were, however, presented only with verbal or screen pictures. Judging from the interest shown, reports on these sessions should be given in printed form as fully as space allows.

I consider that the decision of the Publications Committee to give over the entire technical portion of the November issue to these abstracts is admirable. On behalf of the committee handling the Cleveland meeting, I can only wish that the printing of this information may be of much value to the membership at large, and yield at least a part of the keen enjoyment experienced by the 700 members and guests who were privileged to attend in person.

A. J. HAMMOND
Vice-President, Zone III
CHAIRMAN OF THE SOCIETY'S COMMITTEE FOR THE CLEVELAND MEETING

October 10, 1930

Secretary's Abstract of Special Meeting of the Society, St. Louis

A meeting of the Society was called at the Hotel Jefferson, St. Louis, Mo., on the first day of October 1930, at ten o'clock in the morning. President Coleman presided and about 300 members were present.

In order to carry out fully the previously adopted amendments to Articles V and VII of the Constitution, increasing the number of directors from 18 to 19, the following resolution, after a motion had been duly made and seconded, was unanimously adopted:

> *Resolved* that the number of directors of this corporation be increased from 25 to 26, to consist of the President, 4 Vice-Presidents, 19 Directors, and the 2 latest living Past-Presidents continuing to be members;
>
> *Further Resolved* that the President or a Vice-President and the Secretary or the Assistant Secretary do and they are hereby authorized to execute and file a certificate of such increase in the number of directors, pursuant to the provisions of Article IV of the Membership Corporations Laws of the State of New York.

The report of tellers appointed to canvass the ballot on amendments to Articles V and VII of the Constitution, re-membership qualifications, was presented showing a total vote from 3,945 eligible members; 3,735 being in favor, and 210 not in favor of the amendments. Since more than two-thirds of the votes cast were in the affirmative, the amendments were thereupon declared adopted and, in accordance with the Constitution, declared to go into effect in 30 days.

There being no other business, the meeting adjourned.

Secretary's Abstract of Board of Direction Meeting

THE Board of Direction met at the Jefferson Hotel, St. Louis, Mo., on September 29 and 30, 1930. President J. F. Coleman was in the chair, and George T. Seabury, Secretary, and present also were Messrs. Budd, Bush, Dougherty, Dusenbury, Dyer, Eddy, Gowdy, Hammond, Howe, Johnston, Knowles, Lupfer, MacCrea, Marston, Morris, Nicholson, Pirnie, Reichmann, Stevens, Thomas, and Winsor.

Approval of Minutes

On motion, the minutes of the meeting of the Board held on July 7–8, 1930, and of the Executive Committee, held on August 11, 1930, were approved.

Francis Lee Stuart Nominated for President

The Nominating Committee reported its unanimous selection of Francis Lee Stuart as the "Official Nominee" for President for 1931. Mr. Stuart's acceptance by telegram was subsequently received.

John R. Freeman Made Honorary Member

John Ripley Freeman, Past-President, Am. Soc. C.E., was elected an Honorary Member of the Society.

Rules for Phebe Hobson Fowler Architectural Award Changed

The rules governing the Phebe Hobson Fowler Architectural Award were changed to provide a Committee of Award of five members of the Society, with terms of one, two, three, and four years upon first appointment, and thereafter with terms of four years, and a fifth member from the Board of Direction to act as contact member, with a term of one year. The word "prize" was eliminated, "award" being substituted. Local Sections also are to be asked to contribute suggestions to the Award Committee.

Earthquake Resistant Construction

The Secretary was instructed to transmit to the Director of the Budget a resolution endorsing the program of the United States Coast and Geodetic Survey, and the action of the Secretary of Commerce whereby the Survey is to enlarge its present seismological work to undertake the measurement of periods, amplitudes, and accelerations of earthquakes by specially designed seismographs, in order to obtain data to be used in advancing the design of structures to resist earthquakes. The resolution further urged the Director of the Budget to approve and support the appropriation for this purpose understood to be included in the budget of the Department of Commerce.

1933 World's Fair Program

General approval was given to a proposed program for participation by the engineering societies in the Century of Science World's Fair to be held in Chicago in 1933. A committee, composed of A. J. Hammond, Chairman, Charles F. Loweth, and Albert Reichmann, was appointed to collaborate with similar committees from the Societies of Mining, Mechanical, and Electrical Engineers, and the Western Society of Engineers.

Hoover Dam

A resolution commending the naming of the great dam to be built in Black Canyon, the "Hoover Dam," after President Hoover, an engineer, was adopted, and a communication to the Secretary of the Interior, who so designated the proposed structure, was approved.

American Engineering Council Representatives

The following representatives to the American Engineering Council for terms to end January 1, 1933, were designated: C. E. Smith and John P. Hogan, new appointees; and H. S. Crocker, C. E. Grunsky, A. J. Hammond, J. C. Hoyt, Anson Marston, and Francis Lee Stuart, reappointed for the same term.

Prizes for Society Papers

Confirming the report of the Society's prize committee, the following prizes were awarded for 1930:

For the Norman Medal, Paper No. 1704, "The Science of Foundations—Its Present and Future," by Charles Terzaghi.

For the J. James R. Croes Medal, Paper No. 1713, "Hydrostatic Uplift in Pervious Soils," by H. de B. Parsons.

For the Thomas Fitch Rowland Prize, Paper No. 1700, "Unusual Engineering Features of an Immense Theatre Building," by R. McC. Beanfield.

For the James Laurie Prize Paper No. 1715, "The O'Shaughnessy Dam and Reservoir," by John H. Gregory, C. B. Hoover, and C. B. Cornell.

For the Arthur M. Wellington Prize, Paper No. 1708, "The Virginian Railway Electrification," by George Gibbs.

The Committee further recommended that no award be made this year for the Collingwood Prize for Juniors.

Joint Publicity Agreement

Upon recommendation of the Committee on Publications, a Committee of three was authorized to collaborate with similar committees for the other Founder Societies to develop a working agreement with a commercial publishing house whereby worthy papers or reports, which because of expense are impracticable of publication either from Society funds or as a purely commercial venture, can be made available in print through joint effort.

Committee on Professional Conduct

The Committee on Professional Conduct reported on three cases which were considered and acted upon by the Board.

Committee on Juniors

A report from the Committee on Juniors, suggesting certain procedures to be adopted by the Local Sections of the Society with respect to affording Juniors closer contact with Society members and Society work, was approved.

Committee on Fees

An epitome of the report previously presented by the Committee on Fees, on Charges and Method of Making Charges for Professional Services, was submitted and adopted. This epitome reduced the report to its essentials as they may be viewed from the standpoint of the client. It will be forwarded to the membership with the report as Manuals Nos. 6 and 5, respectively.

Committee on Accredited Schools

On the basis of information presented by the Committee on Accredited Schools, the Board voted that the University of Mississippi and the Mississippi Agricultural and Mechanical College be not considered as accredited schools of engineering. The Board also discontinued the Student Chapters at those institutions, until investigation should disclose that the conditions had been corrected.

Administrative Details

Administrative details, financial matters, resignations, reinstatements, and applications for admission and transfer received appropriate attention.

Francis Lee Stuart Nominated for President

Meeting on September 29, just prior to the sessions of the Board of Direction in St. Louis, the Nominating Committee of the Society chose Francis Lee Stuart, M. Am. Soc. C.E., as official nominee for President. Accordingly, Mr. Stuart's name goes on the ballot to be sent to all members about December 11, with the other official nominees for final vote.

In Society councils and engineering circles, Mr. Stuart has been long and favorably known. His services to the Society have included membership on the Board of Direction from 1909 to 1911, and a term as Vice-President from 1920 to 1921. In addition, he has been, or is now, a representative on such important bodies as Engineering Foundation, Inc., the Engineering Societies Research Board, and the American Engineering Council.

For many years he has maintained consulting offices in New York City, specializing in railroad and terminal problems. His home is in Essex Fells, N.J.

Report of Tellers on Change of Membership Qualifications

St. Louis, Mo.
October 1, 1930

To the Secretary,
American Society of Civil Engineers

Dear Sir:

The tellers appointed to canvass the ballot on the amendment to the Constitution report as follows:

Total number of ballots received		4,062
Deduct:		
Ballots from members in arrears of dues	96	
Ballots without signature	1	

Ballots from members who have died since voting	2	
Ballots with illegible signatures	4	
Ballots from non-corporate members	3	
	106	
Total ballots not canvassed		106
Ballots canvassed by tellers		3,956
Deduct:		
Void ballots	4	
Blank ballots	7	
	11	11
Votes counted		3,945

"Shall the proposed amendement to the Constitution, accompanying circular dated August 20, 1930, be adopted?"

Yes	3,735	Required to carry	2,630
No	210	Carried by	1,105
		Percentage voting "Yes"	94.7
Total vote	3,945		

Respectfully submitted,

Baxter L. Brown, *Chairman*

William Stoecker	E. Paffrath
R. P. Garrett	C. S. Bumann
W. J. Burton	Charles H. Ellaby
E. B. Fay	A. Fred Griffin
John B. Dean	Carl A. Koerner
J. M. Bischoff	Don C. Bowman
Louis Wolf	Jos. L. Loida
Charles E. Galt	Walter A. Heimbuecher
P. T. Simons	S. M. Smith
D. S. McCalman	S. W. Bowen
Arthur J. Widmer	E. C. Dicke
David Kippel	Harry D. Winsor
E. C. Constance	John J. Cope
William M. Penniman	

Tellers

Society Nominates Officers for 1931

Final selection of official nominees for Society offices for the ensuing year was accomplished during the past month. As noted elsewhere in Civil Engineering, the Nominating Committee selected the candidate for President on September 29. Various nominees for other offices were determined as a result of the canvass of the Second Ballot on October 15. The detailed report of the tellers will be found in full in Proceedings for November. A résumé of that report follows:

For Vice-President, Zone II	
J. N. Chester, Pittsburgh	817
For Vice-President, Zone III (one to be elected)	
George H. Fenkell, Detroit	509
Henry M. Waite, Cincinnati	594
For Director, District 1 (two to be elected)	
L. G. Holleran, New York	516
C. A. Mead, Newark, N.J.	533
For Director, District 2	
Henry R. Buck, Hartford, Conn.	233
For Director, District 6 (one to be elected)	
Edwin K. Morse, Pittsburgh	147
Thomas J. Wilkerson, Beaver Falls, Pa.	109
For Director, District 10 (one to be elected)	
H. D. Mendenhall, Lakeland, Fla.	221
D. H. Wood, Chattanooga, Tenn.	44
For Director, District 13	
Frederick C. Herrmann, San Francisco	238

In accordance with the provision of the Constitution, the final ballot for the election of officers will be issued to the entire membership in time for canvassing at the Annual Meeting in January 1931, and will carry the names of the following "Official Nominees."

For President, Francis Lee Stuart, of New York, N.Y.
For Vice-President, Zone II, J. N. Chester
For Vice-President, Zone III, Henry M. Waite
For Directors:

District No. 1, L. G. Holleran and C. A. Mead
District No. 2, Henry R. Buck
District No. 6, Edwin K. Morse
District No. 10, H. D. Mendenhall
District No. 13, Frederick C. Herrmann

Credit to Whom Credit Is Due

In common with other Society meetings, the Cleveland Convention, July 9 to 12, 1930, went along as if on magic wings—no delays, no hitches, no omissions. But that does not mean there was no machinery at work. The mere fact that it did not show is all the more proof that it was functioning perfectly.

In this issue, abstracts of the Technical Sessions are presented as generously as space permits, with the object of giving the maximum of immediate information for the benefit of every member. If the program was good, that was the result of long and hard work on somebody's part. It is only justice that these people should receive their due recognition.

In general charge for the Society was the Northern Regional Meetings Committee, composed of A. J. Hammond, Vice-President of the Society, Chairman; and Ralph Budd, Harrison P. Eddy, Morris Knowles, Edward P. Lupfer, Clyde T. Morris, A. F. Reichmann, and Charles H. Stevens, Directors.

Locally, the meeting was in charge of an Executive Committee headed by Ambrose Swasey, Honorary Member of the Society, as Honorary Chairman; George B. Sowers, President of the Cleveland Section, as Chairman; Edward Linders, Secretary; and with the following Committee Chairmen: Finance, James H. Small, Jr.; Entertainment, Howard W. Green; Program, W. B. Thomson; Reception, James H. Herron; Publicity, Edward E. Duff, Jr.; Hotel and Registration, Mark Swisher; Transportation, William E. Pease; Ladies Executive Committee, Mrs. George B. Gascoigne; Ladies Reception Committee, Mrs. James H. Herron; Ladies Entertainment Committee, Mrs. Howard W. Green; and Ladies Sightseeing Committee, Mrs. Wilbur J. Watson.

The Akron Local Committee consisted of Fred E. Swineford, H. H. Harsh, E. D. Barstow, and G. F. Pfeiffer.

Programs for the various Division Meetings were under the supervision of the respective chairmen of the Division Executive Committee, as follows: City Planning Division, W. W. DeBerard; Construction Division, J. P. H. Perry; Sanitary Engineering Division, W. H. Dittoe; Structural Division, V. G. Thomassen; and Waterways Division, Louis C. Sabin.

It goes without saying that, in addition to all these officials who were directly responsible, there were a large number of others, some as members of a committee and some without official designation, who contributed much of their time and effort to make the Cleveland Meeting a real success. Let each of these accept without designation the gratitude of all those who enjoyed and profited by the spendid program presented.

St. Louis Entertains the Fall Meeting

It was fortunate that the opening baseball games of the World's Series between the Philadelphia Athletics and the St. Louis Cardinals were not played on the home lot at the latter city—else many well laid plans would certainly have gone "agley."

Without that counter attraction, and with the relief from congestion that accompanied it, the Society's Fall Meeting, held at St. Louis on October 1, 2, and 3, was marked by a large attendance, close interest in technical sessions, and particularly happy participation in technical excursions and social events. Twenty-five papers of excellent quality were read and induced animated discussion in more than one instance.

Filled and Overflowing

Study of some of the phases of the changing city which may be of peculiar interest to technical men and economists—and, it is hoped, to the more forward looking of the citizenship—occupied the attention of an audience of nearly 400 on Wednesday, the first of the four-day meetings. "Why the City?" a paper by W. F. Gephart, Vice-President of the First National Bank of St. Louis, stated the problems of mass transportation, coordination of terminals, municipal drainage, water supply, city layout, and supervised regional expansion, which were analyzed in subsequent papers.

Thursday morning and Friday morning were devoted to technical sessions, interested attendance upon which closely filled each room and the standing room in the adjacent corridors. In one instance it necessitated the transfer of speakers, equipment, and audience to another floor of the hotel where a large hall was made available.

Thursday afternoon and Friday afternoon were devoted to excursions of one kind or another—an inspection of the city, its residences and parks, by bus; a boat trip under the famous bridges across the Mississippi; a tour to the St. Louis Electric Terminal Railway Company's new terminal; and an auto trip to the municipal airport where, after 100 of the members and guests were given airplane rides, they inspected the process of building airplanes at the Curtiss-Robertson Airplane Manufacturing Company's plant.

Combined Hospitality

Saturday was devoted to an all-day trip by courtesy of the Missouri Pacific Railroad Company through the Ozark Mountains to the $33,000,000 hydro-electric development at Bagnell, Mo. There, as guests of the Union Electric Light and Power Company and the Stone and Webster Engineering Corporation, nearly 600 members and guests taxed the temporary provisions for their entertainment.

Attendance at the several sessions was as follows:

Wednesday, General Session, A.M.: 324, and 24 ladies

Thursday, Construction Division Session: 150

Friday, Construction Division Session: 150

Thursday, Highway Division Session: 50

Friday, Highway Division Session: 60

Thursday, Waterways Division Session: 74

Friday, Surveying and Mapping Division Session: 90

Noticeably in evidence was the hearty hospitality of the St. Louis resident members in their entertainment of the ladies, and at the evening parties; the dinner dance where Past-President Grunsky and Dr. Dyer of Vanderbilt University gave inspiring addresses, and at the Engineers Club, which, while taxed to capacity, seemed to give no apparent concern to the members of the two Washington University sororities who capably cooked and graciously served the supper which preceded an evening of movies, cards, and dancing.

Efficiently Managed

Very efficient, though not obviously so, was the management by the resident members of the multitudinous details incident to carrying on the meeting. Non-efficiency in these respects is measured in inverse proportion as the meeting goes without hitch or annoyance. To say, therefore, that the meeting went with wonderful smoothness is to state that its management was well thought out and executed.

The attendance of 200 students was unusual and a little unexpected, requiring emergency provisions of considerable magnitude. Students were in attendance at all the sessions and excursions and, in addition, they were provided with several inspection trips, luncheons, and dinners of their own. Their special session was held on Thursday afternoon, under the direction of the Committee on Student Chapters.

Alfred Noble Prize Now Open

ONE of the most valuable types of recognition of the attainment of young engineers was instituted in 1929. It is termed the Alfred Noble Prize, being an award from the income of a fund contributed by engineers and others in honor of Alfred Noble, Past-President of the American Society of Civil Engineers, and of the Western Society of Engineers. Being named after one of the most illustrious and best beloved members of the profession in the history of American engineering, its particular purpose is to perpetuate his name and achievements.

Recipients of the award may be members in any grade of one of the four Founder Societies, or of the Western Society of Engineers. The basis of selection will be the content of a technical paper of particular merit accepted by any of the societies for publication, in whole or in abstract. However, provision is made that at the time of the paper's acceptance, the author may not be more than 30 years of age. This, in effect, limits it to the younger engineer, a particularly significant fact as related to Alfred Noble's life.

Specifically, the prize consists of the sum of $500 in cash, together with an artistic certificate suitably engraved. With it goes a letter bearing a statement of the outstanding facts relating to the life and works of Alfred Noble, signed by the President of the American Society of Civil Engineers, which is serving as trustee of the fund.

Selection for this prize is detailed to a committee of five, one from each of the constituent societies. The technical paper winning the award must have been presented in the publications of one of the societies within the twelve months preceding July 15 of any year. Thus it behooves any young authors who have papers meriting consideration to submit them in ample time. To provide for the delays of examination and approval for publication, manuscripts might well be sent in immediately, thus insuring eligibility for the prize covering the year ending July 15, 1931.

Suitable ceremonies will mark the bestowal of the award. The occasion will be one of the general meetings of the society of which the recipient is a member. A representative of the American Society of Civil Engineers will make the official public presentation.

This is one of the largest, if not the very largest, prize of this nature now instituted. The name of Alfred Noble, even these many years after his death, has a glamour which should enrich the traditional importance of this prize, to say nothing of its monetary value. This ample notice is being given in order that no possibility of winning it should be lost for lack of sufficient time.

Thomas P. Kinsley, Member 58 Years

ON SEPTERMBER 23, 1930, at his home in Hamden, Conn., Thomas P. Kinsley, M. Am. Soc. C.E., died at the age of almost 85 years. Born in Manchester, N.H., on October 11, 1845, and joining the Society in February, 1873, Mr. Kinsley had the honor to be its oldest member, his connection having continued for almost 58 consecutive years.

He was in active practice for many years and was widely known among members. More recently, however, he was retired, yet he still kept some contact with his old professional associates. The Society and the Connecticut Section were both represented at his funeral on September 24.

Appointments of Society Representatives

HENRY D. DEWELL, M. Am. Soc. C.E., was appointed the Society's official representative at the inauguration of Robert Gordon Sproul as President of the University of California on October 22, 1930.

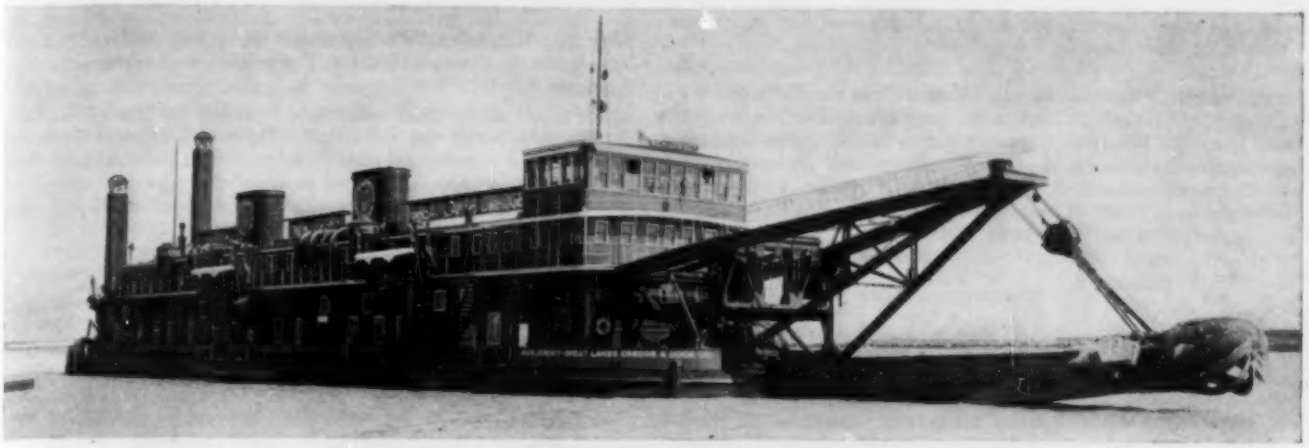
GEORGE W. HAWLEY, M. Am. Soc. C.E., Deputy State Engineer of California, has accepted President Coleman's appointment to fill the vacancy on the Committee on Irrigation Hydraulics caused by the resignation of Mr. Sonderegger.

A. J. HAMMOND, C. F. LOWETH, and A. F. REICHMANN, Members Am. Soc. C.E., were appointed to represent the Society in its proposed participation in a joint engineering program with other societies during the World's Fair in Chicago, in 1933.

JOHN P. HOGAN and C. E. SMITH, Members Am. Soc. C.E., were elected as additional representatives on the assembly of the American Engineering Council.

KARL E. HILGARD, M. Am. Soc. C.E., has been appointed as the Society's official representative to be present at the Seventy-fifth Anniversary of the École Polytechnique Fédérale, to be held in Zurich, November 7–8.

W. P. ROTHROCK, M. Am. Soc. C.E., was appointed to act as the Society's official representative at the Seventy-fifth Anniversary of the founding of the Pennsylvania State College, at State College, Pa., on October 24.



HYDRAULIC PIPE LINE DREDGE "NEW JERSEY"

What's in November Proceedings

DAMS, dredges, highways and land surveys—design and construction; theory and practice—the papers offered to the searching analysis of members in the November PROCEEDINGS might be classified in any of these ways.

Herman Schorer, Assoc. M. Am. Soc. C.E., Chief Engineer of Thebo, Starr, and Anderson, Inc., writes under the title, "The Buttressed Dam of Uniform Strength." This paper presents a general theory of the buttressed dam with definitely known and uniform strength. The author discusses its dimensions and quantity laws and makes suggestions for incorporating theoretical findings in practical designs.

The theory is based on the conception of elementary arched column units which transmit the water pressure from their respective deck areas directly through the buttress, in uniform compression, to the ground. The elementary column units can be combined to form a monolithic buttress system in which the first principle stress is uniform compression throughout and the second principle stress is zero.

Having derived the necessary mathematical formulas to prove his point, Mr. Schorer presents a series of valuable curves by means of which the formulas can be solved directly. A numerical example completes the thesis in a way that should make it one of the outstanding technical contributions of the present year.

The following seven conclusions are defended:

1. The arched column principle provides a simple and exact means for designing buttressed dams of uniform strength.
2. In case of monolithic buttresses designed by this method, the first principle stress is constant compression and the second principle stress is zero.
3. Secondary stresses are practically eliminated by building the arched columns as independent, statically determinate units, separated from each other by continuous joints extending through the deck and buttress system.
4. The buttressed dam of uniform strength contains the minimum possible amount of material for a given design stress.
5. The exact quantities and design elements can be obtained from diagrams in which the main variables are expressed as pure ratios.
6. The independent arched column units permit construction of the dam in economical steps at long-time intervals; no anchorage between the old and new concrete is required, and spillway facilities may be incorporated at each step with no waste of material for this purpose.
7. The buttressed dam of uniform strength is superior in safety and economy to the gravity type for any height to which a concrete dam can be built.

THE HYDRAULIC PIPE LINE DREDGE "NEW JERSEY"

In the design of structures, certainly the civil engineer has a limitless field. Usually, when we think of structures our minds turn to the numerous bridge trusses and multiple building frames that are being assembled all over the United States. Occasionally, however, a unique problem comes up for attention, perhaps not so much from the viewpoint of design technique as from that of the incidental limitations and problems encountered. The forthcoming paper by J. F. Cushing, M. Am. Soc. C.E., describes some of these problems.

The author offers a full description of the design features of the Diesel electric dredge *New Jersey*, operated on the Great Lakes by the Great Lakes Dredge and Dock Company. The steel hull was made exceptionally heavy and rigid, according to Mr. Cushing, so that it could withstand the vibrations of the machinery and even sinking to the bottom.

Special attention was given to the shape of the end so as to provide a hull requiring the least amount of effort for towing. An important part of the paper is a complete discussion of the economic velocity of the charge under normal dredging conditions. From this as a kind of standard, the author presents formulas and practical suggestions to determine the effect of varying the factors that enter into the problem. The paper is completely rounded out by an interesting description of the more important mechanical and electrical units that go to make up such a tremendous plant as that comprising the modern pipe line dredge.

HIGHWAY LOCATION

In a symposium of two short papers, Gibb Gilchrist and A. R. Losh, Assoc. Members Am. Soc. C.E., and State Highway Engineers of Texas and Oklahoma, respectively, describe the general as well as practical considerations that govern this great field of civil engineering.

Mr. Gilchrist deplores the tendency to locate new highways along old routes without considering other phases, such as the cost of traveling a greater distance, or the relative safety characteristics of two routes. He describes highway location by aerial methods as used by the State of Texas and discusses its advantages.

Mr. Losh, in turn, deplores the tendency to consider highway building as primarily of local importance. He outlines a convincing argument against locating highways primarily "for present needs."

RELOCATING LAND SURVEYS

Placing before the Society an extremely interesting account of early surveying methods and laws, B. F. Williams, M. Am. Soc. C.E., describes problems that confront locating engineers everywhere. This paper, with the two included in the highway symposium, was first reported as part of the program of the Spring Meeting at Dallas, Texas, and was briefly abstracted in the August, 1929, PROCEEDINGS. The three papers mentioned, however, were considered to include material in one form or another that is worthy of full discussion by the entire membership. They are published now, therefore, in complete form.

Locations for 1931 Society Meetings Selected

Regional Meetings Committee has designated the following locations.

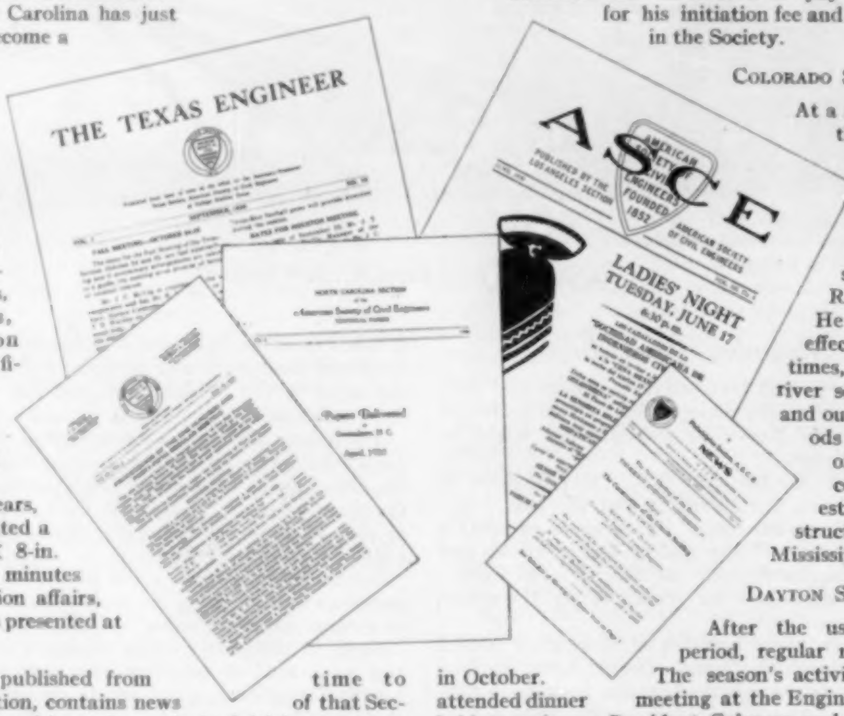
Spring Meeting, April, Norfolk, Va.
Summer Meeting, July, Tacoma, Wash.
Fall Meeting, October, St. Paul, Minn.

News of Local Sections

LOCAL SECTIONS PUBLICATIONS

FROM time to time the Society receives from the Sections copies of their publications. These take numerous forms, as may be seen from the illustration reproduced here. Without doubt an exceedingly useful purpose is thereby served and the members of the Society in each region are benefited.

For example, North Carolina has just initiated what is to become a series of *Technical Papers*. The first pamphlet of 48 pages contains the complete proceedings of a two-day annual conference held by the engineers of that vicinity in Greensboro, in April 1930, on the general subject of contracts, specifications, bonds, sureties, arbitration clauses, and corporate finance, all in their relation to the engineer. The section may well be proud of its Vol. 1 of *Technical Papers*.



For a number of years, San Francisco has printed a generously paged, 5 × 8-in. publication containing minutes of meetings, other Section affairs, and the technical papers presented at its bi-monthly sessions.

The Texas Engineer, published from time to time by the Texas Section, contains news of that Section and occasional advertising. It made its initial appearance last year.

The *Philadelphia Section A. S. C. E. News* is a neat little 4 × 6-in. folder containing the schedule of meetings six to nine months in advance, news of local engineers, new members added to the Section, and other items of interest.

Another publication, the *ASCE* of the Los Angeles Section, carries illustrated selected papers from the programs of previous meetings and those of its active sanitary group. Its first page also announces the program of the succeeding meeting. The *ASCE* (pronounced ace) is in its fourth year.

These Local Section publications are indicative of the genuine interest members have in their Sections and the Society.

This and other plentiful evidence shows that Local Sections throughout the country are rolling up their sleeves in order to keep abreast, and possibly a little ahead, of the new Functional Expansion Program inaugurated by the Society. These "weather signs" are extremely encouraging to the workers at the center of things and should be equally encouraging to each individual member.

BALTIMORE SECTION

The Baltimore Section announces its program for monthly meetings, a number of which are to be held jointly with one or more of the local groups of the Founder Societies or the Baltimore Engineers Club. On November 12, C. E. Keefer, Engineer of Sewage Disposal of Baltimore, will discuss "Sewage Treatment in Europe."

Committees have been appointed by President S. L. Thomson on the new publication CIVIL ENGINEERING, and on the Functional Expansion Program. Contact men on both Student Chapters and engineering employment in public and quasi-public offices also have been appointed.

CENTRAL OHIO SECTION

The Section held its regular luncheon meeting at the Chittenden Hotel, Columbus, on September 18, 1930, with President Orris Bonney in the chair. The report of the delegates to the Local Sections Conference at Cleveland on July 8th was heard and accepted. Complying with a request from the Society, a local Functional Expansion Program Committee was appointed. Attendance was 19.

The Section's student prize was awarded to Samuel T. Carpenter, member of the Ohio State University Student Chapter, who attained a point average of 3.5 out of a possible 4.0. The Treasurer was instructed to pay the amount necessary for his initiation fee and one year's dues as Junior in the Society.

COLORADO SECTION

At a special dinner meeting of the Section, on August 12, forty-three members and guests assembled at the Denver Athletic Club, to hear W. W. DeBerard, of Chicago, speak on the "Mississippi River Flood Control." He covered the extent and effect of the floods of recent times, the conditions in the river sections subject to flood, and outlined the various methods planned for the control of the river. The talk concluded with an interesting discussion of construction operations along the Mississippi.

DAYTON SECTION

After the usual summer vacation period, regular meetings were resumed in October. The season's activities began with a well attended dinner meeting at the Engineers' Club on October 7, held to welcome President Coleman and Allen P. Richmond, of the Secretary's staff. Director Clyde T. Morris was a guest. Short talks were made by President Coleman, Mr. Richmond, Director Morris, and Arthur E. Morgan, Past Vice-President of the Section. Over 90 per cent of the membership of the Section attended the meeting.

A program for the season has been mapped out, according to which meetings are to be held on the second Monday of each month at the Engineers' Club.

DETROIT SECTION

At a joint meeting with the Student Chapter of the University of Michigan, on March 26, Colonel Burnside R. Value delivered a paper on "The Detroit Windsor Tunnel." Forty-nine were present.

On April 16 a joint meeting with the Student Chapter of the Michigan State College was held at East Lansing. Seventy-eight interested engineers listened to M. De Glopper, of the State Highway Department, and to W. J. Wallace, of the Detroit City Engineer's Office.

Returned delegates from the World Engineering Congress, Wm. R. Kales, F. C. McMath, and George H. Fenkell, were honored on May 23 at a joint meeting with the Detroit Engineering Society at which ninety-eight were present. Mr. Kales presented a descriptive talk on his "Trip around the World."

The Section's regular meeting was held on June 3rd, at which time support for the Cleveland Convention was pledged. Action was taken on the investigation of the Southfield sewer failure, and a committee was appointed. Attendance was twenty-eight.

At the Annual Meeting held on October 7, 1930, the following officers were elected and installed for the coming year of 1930–1931: President, A. Harrington Place; 1st Vice-President, William C. Hoad; 2nd Vice-President, Laurence G. Lenhardt; and Secretary-Treasurer, Forrest E. Weber.

LOS ANGELES SECTION

The meeting on October 8 marked the resumption of a plan initiated last year. Just prior to each regular monthly dinner and

meeting, a Junior forum is held, presided over by the President of the Section. To this forum are invited all the Juniors of the Section as well as the members of the Student Chapters at the University of Southern California and the California Institute of Technology. Other members of the Section may attend the forum, but are not permitted to take part unless specifically called upon. The chairmanship of the forum rotates from meeting to meeting, by the choice of those present, it being incumbent upon the chairman to furnish the half-hour program. Often the chairman accepts that challenge and himself gives the paper. The Juniors get some lively discussions among themselves, thereby gaining experience in speaking from the floor and in handling a technical meeting.

Marine salvage was the subject presented to the Section in a skillful and interesting manner by Mr. Gardner of the Merritt-Chapman Scott Corporation of New York and San Pedro, Calif. With moving pictures he illustrated not only the salvaging of wrecked vessels along the coasts of the United States and foreign countries, but also the types of marine construction undertaken by his company. Attendance, one hundred and eight.

The Section has addressed to the California Representatives in Congress a resolution urging the adoption of legislation relative to an appropriation of $40,000 for the budget of the U.S. Coast and Geodetic Survey for the purpose of seismological investigations.

A Central Engineering Council has been formed in Los Angeles, composed of two members from each Local Section of the four Founder Societies, for the purpose of properly presenting to the public the engineering features concerning civic projects. Ralph Reed and Frank Gillelen represent the civil engineers on the council.

The Sanitary Group of the Los Angeles Section resumed its monthly meetings when on September 24 a caravan inspected the experimental sewage reclamation plant of the Los Angeles Bureau of Water Works and Supply. Here a clear, odorless, and tasteless effluent that meets the government standard for drinking water is produced from combined domestic sewage and industrial waste.

New York Section

Something refreshing, alive, and entirely encouraging has been activating the New York Local Section of the Society in the past few months. Externally, this has been made evident to the members of District No. 1 by an active campaign to re-enlist the interest of every one qualified to enroll his name in the Local Section year book.

A vigorous Membership Committee, headed by George W. Fuller, has presistently laid its proposition before the local membership, and the Program Committee, guided by Harold M. Lewis, has backed it up with a schedule that most engineers would recognize as difficult to beat. The season program follows:

October 15. Increasing the Vehicular Capacity of Existing Bridges and the Planning of New Traffic Facilities.

November 5. Special meeting and inspection at the exhibition rooms of the Westinghouse Lighting Institute, Grand Central Palace, New York City. Special program. Ladies invited.

November 19. "Soil Pressures," paper based on research conducted in connection with the Houston Street Subway.

December 17. Current Practice in Subaqueous Tunnels.

January 7. Construction Methods Employed in the Bank of Manhattan Building, New York City.

February 18. The 38th Street-East River Vehicular Tunnel; traffic facilities, ventilation, and related subjects.

March 18. How Is the New York City Water Supply Demand for the Next Decade to Be Met?

April 15. The Ward's Island Sewage Disposal Plant.

May 20. Annual Meeting.

Portland Section

The Fall Meeting of the Section, attended by an interested group of 23 members and three guests, convened at 8:00 P.M. in the University Club on October 8, 1930, with President Schanck presiding. In response to Secretary Seabury's communication of August 22, the appointment of a local Functional Expansion Program Committee was authorized. The first evident step in the Expansion Program, Vol. 1, No. 1, of CIVIL ENGINEERING, received very favorable comment.

The paper of the evening was presented by W. Brenton, Chief Engineer of the Pacific Northwest Public Service Corporation, who explained with lantern slides, the difficult features of the design and construction of the "New Boiler and Turbine Installation of Station L, Portland."

The Section was glad to greet President Stannard of the Tacoma Section. President Stannard presented to President Schanck a gavel made from woods found during the boring of a power tunnel near Tacoma. Geologists estimated that glaciers deposited the material encountered and that the wood was preserved for from 25,000 to 50,000 years. The greetings of the Tacoma Chapter and information as to progress regarding the convention of next summer at Tacoma were very much appreciated.

Northwestern Section

The Annual Meeting, held on October 3, 1930, in the Minneapolis Athletic Club, was attended by 40 members and 16 guests. Director Ralph Budd, and his son, John Budd, were guests of honor. Director Budd described his recent trip through Russia, where he inspected the railroad transportation problem for the Russian Soviet government. The election of new officers was held, President H. D. Lovering handing over the gavel to the new president, William N. Carey. Other officers selected were George E. Loughland, 1st Vice-President; M. W. Hewett, 2nd Vice-President, and Hibbert M. Hill, Secretary-Treasurer.

Sacramento Section

The proposed San Francisco trans-bay bridge was the subject of an address given by Charles E. Andrew, Bridge Engineer for the State Division of Highways, at the meeting on September 16. Mr. Andrew, who served with the Hoover-Young Bridge Commission, described the studies made under the direction of the Commission as to location and type, and the results of the foundation borings. The location chosen was from Rincon Hill, on the San Francisco side, to Goat Island, which will be crossed through a deep cut, and thence to the Key Route Mole, on the Oakland side. It is estimated that the bridge will cost $75,000,000 and will pay for itself in 20 years. Attendance was fifty-six.

On September 23, B. E. Marsh, of the Pacific Telephone and Telegraph Company, gave an illustrated talk on "Fifty Years in the Telephone Industry," showing two reels of motion pictures depicting the development of switchboards and long distance transmission. Forty-one were present.

One hundred and six members and guests were present on September 30 at the Seventh Annual Ladies' Day Luncheon held at the Elks' Club. Otto Von Geldern, life-member Am. Soc. C.E., member of the Board of Regents of the University of California, Past-President of the Pacific Coast Astronomical Society, and President of the Mechanics Institute, addressed the meeting on "General Don Mariano Guadalupe Vallejo." General Vallejo, a Mexican official and owner of a great ranch in what is now Sonoma County, was among the first Californians to advocate the taking over of California by the United States. For a generation, Mr. Von Geldern was a close friend of the General.

The meeting on October 7 was devoted to a discussion of the State Employees Retirement Act, which is to be voted on at the November election. Attendance was thirty-six.

Tacoma Section

A feature of the meeting of the Section held on September 8 at Olympia was the presentation to it by J. L. Stannard, Chief Engineer of Public Utilities of Tacoma and the Section's President, of an exceedingly interesting gavel. It is made from a portion of a log encountered in the construction of the tunnel at the city of Tacoma's Hydro-electric Plant at Cushman. A log jam was found in glacial drift 1,000 ft. in from the tunnel portal at a depth of 350 ft. The wood is perfectly preserved and is estimated by geologists to be at least 25,000 years old. While the Tacoma Section is the youngest Section of The American Society of Civil Engineers, it can justly lay claim to having the oldest gavel in the Society.

Texas Section

The Technical Club of Dallas is embarking on its ninth year of cooperative educational advertising. The purpose of the club's work is to acquaint the public with the function of the various technical interests of the city, and to impress upon those having charge of the construction of improvements in the vicinity the advisability of securing for their planning competent technical advice

ITEMS OF INTEREST

Engineering Events in Brief

OLD STEEL HIGHWAY BRIDGE BEING REPLACED BY MODERN STRUCTURE

WASHINGTON BRIDGE AND DRAW SPAN

Washington Bridge Dedicated, Providence, R.I.

CROSSING the Seekonk River between Providence and East Providence by bridge was first accomplished by John Brown, when the original Washington Bridge was opened to traffic in 1793. That wooden structure was destroyed by fire and when rebuilt a simple swing span was inserted. By 1885, the wooden bridge had served its purpose and was replaced by a steel structure, which carried a street car line on its 27-ft. roadway. A swing span permitted Narragansett Bay boats to pass. By 1920 congestion due to both street car and vehicular traffic was fast becoming intolerable, lines of autos blocks long being held up by the narrow roadway and a too frequently open draw span.

From 1920 to 1924, the State of Rhode Island made thorough and complete investigations of the entire problem of constructing a modern higher level bridge to replace the inadequate steel structure. Its Washington Bridge Commission made its final report to the State Legislature in 1924. In April of 1927, the Commission was directed to proceed with construction. A sum of $3,500,000, the proceeds of two bond issues, was provided, and Clarence W. Hudson, M. Am. Soc. C.E., was selected to design and build the new structure. Merritt-Chapman & Scott Corporation were awarded the contract for the flat sum of $3,000,000, and on September 25, 1930, with appropriate dedication ceremonies, the structure was opened to traffic.

HOUSE OF DRAW-SPAN OPERATOR

The Washington Bridge is a massive structure of concrete, granite, and steel, with a length of 2,407 ft. and a width overall of 85 ft. It measures 80 ft. between railings, which width is made up of two 10-ft. sidewalks and a 60-ft. roadway, providing four 10-ft. automobile lanes, and two 10-ft. street-car lanes. The spans consist of six 105-ft. arches, six 89-ft. arches, a double-leaf bascule draw span over the channel, and three plate girder spans crossing Water Street, the tracks of the New York, New Haven, and Hartford Railroad, and Valley Street in East Providence. Each of the 12 arches consists of 6 reinforced concrete ribs 9 ft. 8 in. wide, which are approximately two ft. thick at the crown and slightly thicker at the piers.

The draw span in the center of the bridge is of the double-leaf bascule type, clears the water at mean tide by 43 ft., has a clear channel width of 100 ft. between fenders, and a present depth of 18 ft. at mean low tide.

At each entrance to the bridge two imposing granite pylons rise 24 ft. above the sidewalk, and bear bronze tablets with appropriate inscriptions. The bridge is lighted by 40 ornamental bronze lamps of 1,000 candle power each, and the 4 towers on the draw-span piers are surmounted by flagpoles having ornate bronze bases with a motif symbolic of early New England history.

The new Washington Bridge is the product of a combination of the highest type of engineering and architectural skill, and will long stand as an object of utility and beauty of which the people of Rhode Island may well be proud.

Another Engineer in Statuary Hall

IN THE ROTUNDA of the National Capitol at Washington stand likenesses of not more than two notable sons or daughters from each State in the Union. Most of these are in marble, hence the name "Statuary Hall," which has thus taken on the atmosphere of a galaxy of national celebrities.

Recently, an engineer has been added to this group, John C. Greenway, the first and so far the only representative from Arizona. General Greenway's appellation reads, "Engineer, Soldier, and Patriot." His military service included a campaign with the Rough-Riders in the Spanish American War and a distinguished experience with the Engineers of the First and Twenty-Sixth Divisions in the World War. He was a member of the American Institute of Mining and Metallurgical Engineers, and served his State in many official capacities.

Commenting on this addition to Statuary Hall, the recent *Bulletin of the Engineering Council* notes the fact that this famous group now includes in its roster four engineers. Robert Fulton is listed as "Artist, Engineer, Inventor of Steamboat," as one of the eminent sons of Pennsylvania. Both representatives from Virginia were notable members of the engineering profession. Robert E. Lee is termed, "Engineer, Soldier, Educator;" and George Washington is listed as "Engineer, Soldier, Patriot, and First President."

Late Deliveries of Civil Engineering

Every effort is being made to insure promptness in the mailing of Civil Engineering. Under a rigid schedule the printer is delivering copies to the post office so that each member should receive his on or soon after the first of the month.

Although this was the program for sending out the October number, some members have reported that their copies were delayed, in some instances as late as October 6. This should not be, except in the case of Western members, who will normally receive the publication about the sixth. In case your copy was unduly delayed or, worse still, did not reach you, will you kindly notify Headquarters immediately so that every effort may be made to correct this difficulty and prevent its recurrence.

Baron Shiba Visits the United States

Baron Chuzaburo Shiba, especially well known to American engineers who attended the World Engineering Congress at Tokyo because of his genuine hospitality during their stay in Japan, passed through the United States during the past month on his return from the World's Power Congress, in Berlin. It was the pleasure of representatives of the Engineering Societies here to entertain this modest member of the Japanese nobility during his sojourn in Quebec, New York, and Washington.

Baron Shiba is not only a recognized world authority on marine engineering, but has also astounded both scientists and engineers with the beautiful combination of mechanics, optics, and kinematography by which he has made studies of air turbines about aeroplane wings and other parts. With his high-speed moving picture equipment, he had made 40,000 exposures per second of smoke- or vapor-colored air currents which were later studied at reduced speeds. One of his classic pictures with this apparatus is that of a rifle bullet passing through an incandescent light globe, the bullet pushing in the glass of the globe much as a finger would push through a toy balloon, the particles of glass falling like snowflakes, and the bullet floating slowly away from the opposite side of the globe.

Baron Shiba is Professor of Mechanical Engineering at Tokyo University; he is a member of the House of Peers, was Vice-President of the World's Engineering Congress, is a Director of the Aeronautical Research Institute of Japan, and Chairman of the Board of the Imperial Japanese Marine Corporation. It is of interest to know that Baron Shiba's daughter is the wife of the Crown Prince of Japan. In spite of all his interests and attainments, the Baron, who is now past 60 years old, travels modestly, unaccompanied and without ostentation, as any American business man might do.

Wearing the Pin

The old-style badge of the Society, so much prized by those who became members prior to 1894, bears the picture of a wye level. More than a thousand of these pins were issued, but today they are rare. Easily recognized by engineers, that emblem was sometimes regarded by the casual layman as a mystic symbol of the craft. At least once it has been misinterpreted.

Several traveling salesmen were getting acquainted in the usual manner; one dealt in hardware, another in dry goods, a third sold groceries. One of them turned to the wearer of the former-type badge, who happened to be sitting with the group, and glancing at the blue shield remarked, "I see that you handle laundry machinery." "What makes you think so?" asked the engineer. "That's easy," replied the salesman, "Your pin has a picture of a clothes wringer on it!"

Clausen Medal Awarded

It was announced at the Annual Meeting of the American Association of Engineers, on October 4, that the Clausen gold medal, given annually for the greatest contribution to the social and economic welfare of the engineering profession, will be awarded this year to J. A. L. Waddell, M. Am. Soc. C.E., Consulting Bridge Engineer of New York. In addition to his professional work, Dr. Waddell is known as the author of many books and technical articles on engineering subjects, and his *De Pontibus* is on most bridge engineers' library shelves.

American Society of Civil Engineers
Annual Meeting Convenes in New York
January 21, 22, 23, 1931

American Association of State Highway Officials
Annual Meeting will be held in Pittsburgh, Pa., November 17–20.

American Water Works Association
Sixteenth Annual Meeting of the Missouri Valley Section will assemble in Cedar Rapids, Iowa, November 5–7. Earle L. Waterman, Secretary, University of Iowa, Iowa City.

Asphalt Paving Conference
Ninth Annual Meeting will be held in Memphis, Tenn., December 1–5.

American Water Works Association
The California Section is holding its Eleventh Annual Convention in Pasadena, October 29, November 1.

Admiral Taylor Honored

The highest honor open to the engineering profession in America, the John Fritz gold medal, has been awarded for 1931 to Admiral David Watson Taylor, retired, "for outstanding achievement in marine architecture, for revolutionary results of persistent research in hull design, for improvement in many types of warships, and for distinguished service as Chief Constructor of the United States Navy during the World War."

The award was made unanimously by the John Fritz Medal Board of Award, composed of four representatives from each of the four Founder Societies, the American Societies of Civil, Mining and Metallurgical, Mechanical, and Electrical Engineers.

His most notable achievement was the design of hulls by which the bow wave is used for ship propulsion, a development reported to have halved the Navy's coal bill. He built the first aerodynamic wind tunnel in the United States and the Shenandoah was designed under his direction. He has many honorary degrees and was decorated by the Government with the Distinguished Service Medal.

Posthumous Honor for Engineer

At the convention of the National Electric Light Association at San Francisco, Calif., on June 19, 1930, the Board of Directors of the American Superpower Corporation announced that it had awarded a capital prize of $10,000 to the late Reuben B. Sleight, Assoc. M. Am. Soc. C.E., for his essay, written in 1925, on "Development of the Electric Light and Power Industry in the United States during the Period 1920–1930."

In the spring of 1925, Bonbright & Co., Inc., Investment Bankers, offered prizes aggregating $10,000 for the best contemporary reviews and forecasts of the electric light and power industry, summarizing the progress of the decade, 1920–1930. Thus the essay was to be a review of five years and a forecast for five years. There were 438 essays submitted, all from unidentified authors, under assumed names, for prizes to be awarded by the Board of Directors of the American Superpower Corporation. This board, in accepting the invitation to make the award, voted an additional prize of $10,000 to be awarded in 1930 for the essay that appeared to have approximated most nearly the facts as they actually occurred. In a preliminary award, Mr. Sleight received one of the major prizes.

Last spring, the Board of Judges unanimously granted the American Superpower Corporation Award of $10,000 to the essay by Mr. Sleight, with the following comment:

"The Board of Judges takes this occasion to express its sincere regret that the author of this essay has died since the prize was offered. His essay,

in the judgment of the Board, is worthy of an enthusiastic tribute. The Judges consider that it treats, in an adequate fashion, practically all phases of the development of the industry, that no important errors of judgment are displayed, and that the author ventured a considerable number of statistical forecasts that now exhibit remarkably small deviations from the actual data.... The Judges have had no difficulty in reaching the unanimous conclusion that the prize be awarded for his essay."

Unfortunately, Mr. Sleight did not live to see the fulfillment of the prophecies made in his essay. In the fall of 1927 he was sent by airplane to investigate flood conditions in Vermont as personal assistant to Herbert Hoover, then Secretary of Commerce. The plane had an accident in landing, and he received injuries from which he subsequently died. The prize of $10,000, awarded posthumously, was therefore paid to Mrs. Sleight. Other events in Mr. Sleight's short but promising career are listed in the memoir published in Vol. 92 of TRANSACTIONS (1928).

NEWS OF ENGINEERS

LUIGI LUIGGI, Honorary Member, Am. Soc. C.E., visited Society Headquarters October 2, en route to Washington, D.C. He is a Senator of the Kingdom of Italy, Honorary President of the National Council of Public Works of Italy, and was recently the recipient of the degree of doctor of engineering from Rensselaer Polytechnic Insitute.

WILLIAM BOWIE, Chief of the Division of Geodesy, and N. H. HECK, Chief of the Division of Terrestrial Magnetism and Seismology, U.S. Coast and Geodetic Survey, attended, as delegates from the United States, the meeting of the International Geodetic and Geophysical Union, held in Stockholm, Sweden, in August. Mr. Bowie has been President of the International Geodetic Association of that Union since 1919 and was re-elected for another term.

DONALD A. DUPLANTIER has accepted an Assistant Professorship in Civil Engineering at the University of Alabama, Tuscaloosa. He was formerly Assistant Engineer for the George J. Glover Company, Inc., of New Orleans.

P. O. RETZKE, who has been structural draftsman on the Picatinny Arsenal at Dover, N.J., has removed to Cheyenne, Wyo., where he is the Supervising Engineer on construction of barracks and officers' quarters at Fort Francis E. Warren.

T. CHALKLEY HATTON, at one time Chief Engineer of the Milwaukee Sewage Disposal Works, has been retained as consultant on the proposed $4,000,000 extensions to the present system.

ROLLAND A. PHILLEO has resigned his position as Draftsman with the American Bridge Company, at Ambridge, Pa., to enter the structural department of the United Engineers and Constructors of Philadelphia.

B. E. W. STOUT, who was President-Treasurer of the General Construction Company of St. Louis, is now Resident Manager of the Lakeside Bridge and Steel Company, of Milwaukee.

JOSEPH F. STILL has become Assistant Engineer of Subway Design on the Advisory Subway Engineering Commission, of Chicago. Before that, he was located at Ocean Falls, B.C.

JOHN F. HAGERTY, formerly Assistant Engineer of the Chicago and W. Indiana Railroad, is now Engineer of the Inland Steel Company, East Chicago, Indiana.

THOMAS A. FORBES has become Chairman of the Technical Committee of the Inter-American Highway Reconnaissance Surveys, located in Balboa, Canal Zone. He was previously with the U.S. Bureau of Public Works in the same city.

THOMAS E. LUNDY is now Assistant City Engineer in charge of a paving project in Livingston, Tex. Before that, he was Assistant Engineer of Jacksonville, Tex.

ARTHUR L. REEDER, formerly Principal Assistant Engineer with H. Burdette Cleveland, of New York, has become Division Engineer of the Mahoning Valley Sanitary Division, Youngstown, Ohio.

E. S. WEED has accepted a position as Assistant Engineer with the Water and Power Resources Bureau, Pennsylvania Department of Forests and Waters, located at New Cumberland, Pa. He was formerly Research Engineer, Supervising Engineers, Inc., in Harrisburg, Pa.

FINN STROMSTED has resigned his position as Structural and Concrete Designer with the Pennsylvania Power and Light Company, of Allentown, Pa., to become Structural Engineer of the Bethlehem Steel Company, with headquarters in Bethlehem, Pa.

J. LYELL CLARKE is now Sanitary Engineer, of Riverside, Ill. He formerly held the same position with the Randolph-Perkins Company, of Chicago.

C. B. CORNELL has become Construction Engineer of the Prettyboy Dam and Reservoir, located in Baltimore. He was formerly Field Engineer of the Mahoning Valley Sanitary District, Youngstown, Ohio.

RALPH FOGG, formerly head of the Civil Engineering Department, at Lehigh University, is now a consulting engineer in New York City. His office is in the Grand Central Terminal.

MAJOR L. E. LYON, Corps of Engineers U.S.A., has changed his station from Montgomery, Ala., to Fort McPherson, Atlanta, Ga., where he is Corps Area Engineer, of the Fourth Corps Area.

GLENN MURPHY, recently instructor in Civil Engineering at the University of Colorado, located at Boulder, Colo., has become Research Assistant in Civil Engineering at the University of Illinois.

JAMES L. FEREBEE, who has been Commissioner of Public Works of West Allis, Wis., has been recently selected Chief Engineer of the Metropolitan Sewerage Commission of Milwaukee.

GEORGE B. SOWERS has been promoted to the post of City Engineer of Cleveland. He was formerly Deputy Commissioner Division of Engineering and Construction, of the same city.

ROBERT HOFFMAN, who previously was Chief Engineer, Department of Public Service of Cleveland, has been appointed consulting engineer for that city.

HENRY WISE is now an Assistant Engineer with the Board of Transportation of New York City. He was formerly Junior Engineer in the Road Engineers Department of the Interborough Rapid Transit Company of New York, N.Y.

RUSSELL D. WELSH, who was connected with the Industrial Properties Corporation of Dallas, Tex., has recently received an appointment as Associate Engineer, Civil, with the U.S. Reclamation Bureau, with offices at Denver.

ERNEST B. HUSSEY, formerly Construction Civil Engineer, and MILES E. CLARK, formerly Construction Engineer, both of Seattle, Wash., have announced their association as Civil Engineers, with offices at 1310–1313 Alaska Building.

C. R. THOMAS, formerly editor of *Highway Engineer and Contractor*, Chicago, has become Executive Engineer, City Officials' Division of the American Road Builders Association. His office will be located in the National Press Building at Washington, D.C.

G. A. BRACHER, formerly Resident Engineer of the State Highway Department of Jacksonville, Tex., is now located at Liberty, Tex., where he holds the position of County Engineer with the Liberty County Highway Department.

BYRON C. MCCURDY, who has been Assistant County Engineer of St. Clair County, Ill., with headquarters at Belleville, has become County Superintendent of Highways. He is still located at Belleville.

JOHN M. REARDON has been promoted to the position of Superintendent of Construction and Repair, of the City of St. Paul. He was formerly Assistant Construction Engineer of the same city.

RAY E. COPELAND has now become Assistant Civil Engineer in the United States Engineer Office, Second Chicago District, Chicago, Ill. He was formerly Hydrographic Engineer of the Los Angeles County Flood Control District.

ROGER G. KURTOSSY, formerly Steel Designer, Ball and Snyder, 183 Madison Ave., New York, N.Y., is at present with the National Fireproofing Corporation, 122 East 42nd Street, New York, N.Y.

S. B. NEVIUS, who has been Construction Engineer with Strong and Macdonald, Inc., 1020 Puget Sound Bank Building, Tacoma, Wash., is now associated with the Sydney E. Junkins Company, Ltd., Engineers, 555 Howe Street, Vancouver, British Columbia.

DANA E. KEPNER is now Secretary-Treasurer of the Rocky Mountains Section of the American Water Works Association, with headquarters in Denver. Prior to that, he was District Manager of the Pacific States Cast Iron Pipe Company of the same city.

Changes in Membership Grades

Additions, Transfers, Reinstatements, Deaths, and Resignations

From September 11 to October 10, 1930

New Honorary Member

Freeman, John Ripley. (Jun., June '82; M., April '89; Director, 1896–1898; Vice-President, 1902–1903; President, 1922; Hon. M., Sept. '30.) Consulting Hydr. Engr.; also President, Manufacturers Mutual Fire Insurance Co., 815 Grosvenor Bldg., Providence, R.I.

Additions to Membership

Bell, Hector Hercules. (Assoc. M., June '30.) Dist. Engr., Tramways Board, Melbourne, Victoria, Australia.

Brossa Ramoneda, Luis José. (Assoc. M., Aug. '30.) Contr. Engr., Salon de San Juan 127 pral., Barcelona, Spain.

Brown, Lytle. (M., June '30.) Maj.-Gen., Chief of Engrs., U. S. A. Munitions Bldg., Washington, D.C.

Brushaber, Robert Frederick. (Assoc. M., July '30.) Engr. Accountant, Board of Transportation, 250 Hudson St., New York, N.Y.

Burnham, Philip Smith. (Jun., May '30.) 123 South Highland Ave., Ossining, N.Y.

Copeland, Ronald Everett. (Assoc. M., June '30.) Eng., Cement Products Bureau, Portland Cement Assoc., Chicago, Ill.

Cushman, Allerton Richardson. (Jun., July '30.) Engr. Asst., Hydr. Dept., New England Power Const. Co., 89 Broad St., Boston, Mass.

Deliz, Luis Agustin. (Assoc. M., Feb. '30.) Asst. Engr., James H. Fuertes, 822 Woolworth Bldg., New York, N.Y.

Dougan, Henry Knox. (M., June '30.) Executive Asst., G. N. Ry., St. Paul, Minn.

Ela, Arthur John. (M., Aug. '30.) 817 Alaska Bldg., Seattle, Wash.

Fishgrund, Henry. (Assoc. M., June '30.) Asst. Engr., Board of Transportation, 2 Stone St., New York, N.Y.

Fonseca, David. (Assoc. M., Apr. '30.) Structural Designer, Byllesby Eng. & Management Corp., 231 South La Salle St., Chicago, Ill.

Franklin, Edwin Meier. (Jun., April '30.) With Ken-Wel Sporting Goods Co., Inc., 5 Beverly Pl., Utica, N.Y.

Gallagher, George Augustus. (Assoc. M., July '30.) Engr. and Salesman, Pacific Tank & Piper Co., San Francisco, Calif.

Gallagher, James. (Assoc. M., June '30.) Asst. Bridge Engr., State Highway Comm., Box 1103, Sacramento, Calif.

Hansen, James Harold. (Jun., July '30.) Care, Turner Constr. Co., Brentwood, N.Y.

Hillyer, Justin Dwight. (Jun., May '30.) Sales Engr., Sullivan Machinery Co., 277 Crestwood Ave., Buffalo, N.Y.

Kelly, Earl Michael. (Assoc. M., Aug. '30.) Engr., The Dorr Co., Inc., 714 Central Bldg., Los Angeles, Calif.

Kennedy, Clarence James. (M., June '30.) Plant Engr., Gary Plant, Am. Bridge Co., Gary, Ind.

Kepner, Harold Raymond. (Assoc. M., June '30.) Utah State Agriculture College, Logan, Utah.

Lamborn, Samuel West. (M., June '30) Asst. Designing Engr., Dept. of City Transit, Philadelphia, Pa.

Law, Charles William. (Jun., Aug. '30.) 506 West German St., Herkimer, N.Y.

Laws, Frank Wesley. (Assoc. M., Nov. '29.) Asst. Designing Engr., Main Roads Board of New South Wales, 309 Castlereagh St., Sydney, N.S.W., Australia.

Lucinski, Daniel Joseph. (Jun., July '30.) Junior Lighthouse Engr., U.S. Lighthouse Service, Philadelphia, Pa.

McAfee, Lloyd Tevis. (M., July '30.) Chief Asst. City Engr., Room 351 City Hall, San Francisco, Calif.

McKean, James Percival. (Jun., '26; Assoc. M., Aug. '30.) Instr., Civ. Eng., Gen. Eng. Dept., Iowa State College, Ames, Iowa.

Mauzy, Andrew Benjamin. (Assoc. M., '24; M., Sept. '30.) Water Conservator, Bureau of Water, Room 22, City Hall, Jersey City, N.J.

Messier, Charles Jeremiah. (Assoc. M., June '30.) Sales Engr., New England Iron Works, New Haven, Conn.

Metcalf, Bradley Revere. (M., June '30.) Box 1322, Tucson, Ariz.

Mitchell, Thomas Jefferson. (Affiliate, Aug. '30.) Vice-President, Crescent Brick Co., 807 Empire Bldg., Pittsburgh, Pa.

Michelsen, Fridtjof Rordam. (Assoc. M., June '30.) Chief Engr., Fred T. Ley & Cia., Ltda., Apartado 1529, Lima, Peru.

Molther, Francis Rattoone. (Assoc. M., Aug. '30.) Architect, Dept. of Public Works, Republic of Panama, Box 488, Ancon, Canal Zone.

Moran, Anthony Thomas. (M., July '30.) Engr., Empire City Subway Co., New York, N.Y.

Neuffer, Herman Christopher. (M., April '30.) Engr., Representing Secretary of Interior and Commissioner of Indian Affairs, Middle Rio Grande Conservancy, Box 445, Albuquerque, N.Mex.

Ogle, Henry Lane. (Assoc. M., '24; M., Sept. '30.) President, Lane Ogle, Inc., Bank of Manhattan Bldg., Bridge Plaza, Long Island City, N.Y.

Rust, Thomas H. (Assoc. M., Aug. '30.) Bridge Designer, Cincinnati Union Terminal Co., Cincinnati, Ohio.

Scanlin, Ralph Henry. (Jun., May '30.) Draftsman, Am. Bridge Co., Toledo, Ohio.

Stuckey, Arthur Ray. (Assoc. M., July '30.) Office Engr., Stone & Webster Eng. Corp., 302 Star Bldg., St. Louis, Mo.

Weymouth, Robert Issell. (Assoc. M., Aug. '30.) Chief. Engr. and Surv., Egham Urban Dist. Council, 155 High St., Egham, Surrey, England.

Wolfard, Noah Ellsworth. (M., Apr. '30.) Assoc. Prof., Civ. Eng., Univ. of Oklahoma, Norman, Okla.

Membership Transfers

Aldrich, Ellwood Harmon. (Assoc. M., '22; M., July '30.) Asst. Engr., Nicholas S. Hill, Jr., 112 East 19th St., New York, N.Y.

Campbell, Harry Valentine. (Assoc. M., '23; M., July '30.) Supt. of Constr., Manila R. R., Manila, Philippine Islands.

Dauner, Edward Jacob. (Assoc. M., '28; M., Sept. '30.) Surveyor and Regulator, 16th Dist., Bureau of Eng. and Surveys, Philadelphia, Pa.

Evans, Wallace Bryant. (Jun., '26; Assoc. M., July '30.) Job Engr., United Engrs. & Constructors, Inc., 112 North Broad St., Philadelphia, Pa.

Ginsberg, William. (Assoc. M., '22; M., Sept. '30.) 2d Vice-President and Mgr. of Constr., Adelson Constr. & Eng. Corp., 565 Fifth Ave., New York, N.Y.

Greene, Edward Lloyd. (Jun., '27; Assoc. M., Apr. '30.) 1715 Capitol Way, Olympia, Wash.

Lassiter, Richard Thornton. (Jun., '25; Assoc. M., Aug. '30.) With Henry Manley, New York, N.Y.

Parkhill, Gordon Wight. (June., '26; Assoc. M., Jan. '30.) Asst. Engr., H. N. Roberts Co., Box 1115, Lubbock, Tex.

Reinstatements

Groner, Tryove Daniel Bodtker, M., reinstated Sept. '30.

Matsumoto, Torato, M., reinstated Sept. '30.

Cleveland, Lou Baker, Assoc. M., reinstated Sept., '30.

Sharpe, Leslie Purkis, Jun., reinstated Sept. '30.

Resignations

Knox, Samuel Lippincott Griswold, M., resigned Sept. '30.

Mason, William Pitt, M., resigned Sept. '30.

Murray, Joseph Augustine, Jr., Assoc. M., resigned Sept. '30.

Scheidenhelm, Edward Louis, Jr., Jun., resigned Sept. '30.

Deaths

Byers, Maxwell Cunningham. Elected M., June 6, 1911; died Sept., 23, 1930.

Carson, William Waller. Elected M., Nov. 2, 1892; died Feb. 7, 1930.

Chagnaud, Léon-Jean. Elected Hon. M., June 19, 1922; died July 31, 1930.

Goodwin, Arthur Bates. Elected Assoc. M., July 6, 1920; died Sept. 21, 1930.

Hill, Edward Baxter. Elected Assoc. M., July 6, 1925; died April 26, 1930.

Kinsley, Thomas Pearson. Elected M., Feb. 5, 1873; died Sept. 23, 1930.

Lotter, Henry Howell. Elected M., Sept. 9, 1919; died Sept. 9, 1930.

Porter, George Frederick. Elected M., Oct. 1, 1913; died Sept. 20, 1930.

Raitt, John William. Elected M., May 19, 1924; died Sept., 27, 1930.

Scripko, Nicholas Alexander. Elected Assoc. M., Oct. 14, 1929; died Sept. 21, 1930.

Sias, Robert Mitchell. Elected M., Feb. 25, 1924; died Oct. 4, 1930.

Simpson, Erastus Roland. Elected Assoc. M., Nov. 4, 1903; died Sept. 24, 1930.

TOTAL MEMBERSHIP AS OF OCTOBER 10, 1930

Members	5,772	
Associate Members	6,128	
Corporate Members		11,900
Honorary Members		17
Juniors		2,319
Affiliates		141
Fellows		7
Total		14,384

Men and Positions Available

These items are from information furnished by the Engineering Societies Employment Service with offices in Chicago, New York, and San Francisco. The Service is available to all members of the contributing societies. A complete statement of the procedure, the location of offices, and the fees is to be found on page 87 of the 1930 Year Book of the Society. Unless otherwise noted, replies should be addressed to the key number, Engineering Societies Employment Service, 31 West 39th Street, New York, N.Y.

Men Available

Structural Engineer; Assoc. M. Am. Soc. C.E; university graduate; age 29; married; six and one-half years broad experience with fabricators and engineers, including work on bridges, tier buildings, subways, and industrial buildings. Prefers position as sales engineer or designer. C-7922.

Civil Engineer; Assoc. M. Am. Soc. C.E.; graduate civil and structural engineer; age 40; married. Twenty-four years broad experience; mechanical and industrial building design, plant layout, estimates, office buildings, general construction, mechanical installations, maintenance, equipment, highways, and pavements. Available at once. Location immaterial, provided salary is satisfactory. C-7958.

Construction Engineer; graduate of finest engineering school, desires permanent connection in above or related fields. Will consider sales engineering of construction materials or improved building features. Permanence, with assured future, of primary importance. Excellent references regarding integrity, ability, and industry. Services available immediately. Any location in the United States acceptable. C-7907.

Technically Trained Engineer; Jun. Am. Soc. C.E.; six years experience on sewer and disposal plants, waterworks, and pipe lines; has made a study of flow of streams for hydro-electric projects; of concrete roads and concrete bridges of arch and girder design. Would like a position with a contractor or engineer. C-5730.

Young College Graduate, civil engineering department of Lafayette College, class 1930, desires position with construction company. Wishes to be placed in the field, or to start as a structural designer of steel and concrete. C-7964.

Railway Engineer; Jun. Am. Soc. C.E.; graduate in transportation engineering, Massachusetts Institute of Technology; member Tau Beta Pi. Field experience in maintenance of way; experienced in drafting; two years experience in economics of railway location. Would be particularly interested in training course leading to responsible positions in railway operation. Now employed. C-7996.

Graduate Civil Engineer; Jun. Am. Soc. C.E.; age 30; thoroughly versed in every type of concrete design, including statically indeterminate systems with variable moment of inertia, arches, flat slabs, cellular structures; eight years responsible experience in connection with industrial developments, water power, and pumping plants. Available November 1. C-5058.

Structural Engineer; Assoc. M. Am. Soc. C.E.; American; age 39; capable executive, contracting and sales. Nineteen years experience unloading towers, conveyors, drag scrapers, skip hoists, and other material-handling equipment. Familiar with New York and New England territory, but will go anywhere. C-5316.

Designer, Detailer; Assoc. M. Am. Soc. C.E.; four years experience in reinforced concrete, including bridges, viaducts, highways, buildings; two and one-half years design of steel bridges and buildings; two years in the hydraulic field, mainly hydro-electric development. Expert in computing secondary wind and temperature stresses, flow of water. European college education. B-9092.

Civil Engineer; Assoc. M. Am. Soc. C.E.; Cornell graduate; age 39; practice covers 15 years general experience in mechanical and civil engineering. Design and construction of industrial buildings, office buildings, warehouses, power houses, substations, and transmission lines; engineering studies of waterworks, investigations, reports, heavy foundations pile, open caisson. Desires executive position with leading architects, engineers, or contractors. Good personality. B-9576.

Civil Engineer; Assoc. M. Am. Soc. C.E.; age 32; graduate of university in northwestern Europe; 5 years experience in New York City as designer and checker of structural steel, reinforced concrete, and timber construction for industrial buildings; one year field experience. Would like permanent position as chief draftsman or squad leader. B-7845.

Hydraulic Engineer; Jun. Am. Soc. C.E.; B.E.; M.S.; age 27; married. Five years experience in hydraulic investigation and design, embracing hydro-electric, drainage, flood control, and irrigation projects. Desires position with a future. Location immaterial. C-4172.

Civil Engineer; Assoc. M. Am. Soc. C.E.; age 41; married, technical education; 18 years experience; surveys, reports, estimates, municipal improvements, location, design, construction highways, railroads, including terminal improvements, grade, and line revisions. For past four years, experience, with responsibility, on construction foundations and erection of railroad bridges. Now employed. Desires permanent connection with engineer or contractor. Available immediately. C-8113.

Construction Engineer, or Superintendent; M. Am. Soc. C.E.; 30 years foreign experience, building railways, hydro-electric, reinforced-concrete, wharves; and industrial structures; experience includes work in West Indies, South America, France, Far East; speaks Spanish. Can handle by administration or can supervise local contractors, write specifications, and make contracts. Will go anywhere. A-5380.

Recent Graduate; age 24; single; desires work with a construction or mining company; speaks Spanish. Good topographical draftsman, with a good college record. Outside experience in surveying and drafting. Willing to start in any line and prove merit. Available on short notice. C-8070.

Civil Engineer; M. Am. Soc. C.E.; experienced in design and construction of buildings, hydro-electric and other structures, investigation and exploration; executive experience. Full details upon request. C-5629.

Civil Engineer; student member; age 22, with 2 years of work at Cornell University and 5 years experience in mechanical, structural, electrical, and topographical tracing, and lettering, desires a temporary position in any of the fields listed. C-8087.

Civil Engineer, 1930 graduate, desires a position with a road-building firm or a municipality located in vicinity of New York City. Summers spent with city surveying party. Available now. C-8158.

Graduate Engineer; Jun. Am. Soc. C.E.; class of 1924; single; age 28; six years construction work principally heavy pile foundations, in and around New York City; good line and grade man, timekeeper, cost-account material clerk; and field engineer. Also some supervision experience. Available immediately. Any location. C-145.

Engineer; Assoc. M. Am. Soc. C.E.; age 35, seeks industrial and investment analysis work with established organization. Best banking and professional references; 14 years varied experience, United States, Latin America, Europe, Orient. Graduate; married; speaks Spanish, French. Experience includes industrial analyses, reports, cost finding, all phases of financing projects, foreign investigations. Good organizer and cooperator. C-6258.

Municipal and Sanitary Engineer; Assoc. M. Am. Soc. C.E.; married; graduate sanitary engineer; 20 years designing and construction experience, covering sewerage, drainage, water supply, flood control, paving, real estate development, investigations, estimates, and reports. Desires responsible position in New York Metropolitan District. Available on short notice. B-1829.

Licensed Professional Engineer; Assoc. M. Am. Soc. C.E.; age 49; 25 years experience in railway, highway, municipal, harbor and industrial engineering, exploration, boundary and property surveying, mostly in foreign countries. Speaks Danish; working knowledge of Spanish. Available on short notice to take charge of work, or for investigations and reports. B-8567.

Civil Engineer; M. Am. Soc. C.E.; 23 years experience in design and construction of steel and reinforced concrete bridges, buildings, railroad and municipal works. Open for position as chief engineer, superintendent, or something similar. B-9497.

Engineer, Executive; M. Am. Soc. C.E.; age 41; graduate civil engineer with degrees; broad experience in structural and industrial work, including allied mechanical lines. B-6046.

Licensed Civil Engineer and Surveyor in State of New York, Assoc. M. Am. Soc. C.E.; age 34; desires position within metropolitan area requiring varied activities. Has had two years sub-professional work, two and one-half years railroad experience, and three and one-half years general surveying and village engineering in responsible position. B-5190.

Construction Executive; Assoc. M. Am. Soc. C.E.; superintendent or engineer; age 50; married; graduate civil engineer, Sheffield Scientific School, Yale University; 20 years full charge construction, railroad, plain and reinforced concrete, bridge, highway, and all kinds municipal work, sewerage systems, foundations, industrial and commercial buildings. Can use Spanish. Location, New York, South, or foreign country. C-675.

Graduate Civil Engineer; Jun. Am. Soc. C.E.; B.C.E. degree; age 27; married. Four years experience as assistant to general building contractors in the East; responsible estimator, experienced in quantity take-off, pricing, sub-bid and assembly, office management, purchasing, drafting, and expediting. Desires permanent connection with reliable contractor at reasonable salary. C-5869.

Civil Engineer; Assoc. M. Am. Soc. C.E.; single; 20 years experience. Executive type with outstanding record of accomplishment. Twelve years in Latin American countries, with broad experience on highway and railroad location and construction; harbor development; municipal improvements; investigations and reports. Has negotiated several large foreign contracts. Location secondary. B-4130.

Engineer; Assoc. M. Am. Soc. C.E.; graduate in law and personnel administration; 20 years experience in construction, purchasing, promotion, investigation. Seeks position, preferably New York City, but will go elsewhere, where engineering experience and legal knowledge may be combined; local representative or limited traveling. Available on short notice. B-5501.

Graduate Civil Engineer; Assoc. M. Am. Soc. C.E.; age 36; married; 12 years varied experience, including all branches highway engineering; municipal engineer for several villages, airport, hangar construction, private practice in general engineering, and surveying. L.S. and P.E. licenses, New York. Desires responsible position. Metropolitan New York preferred, but will consider any location. C-1688.

Structural Engineer; Jun. Am. Soc. C.E.; age 28; married; graduate; five years experience, with responsibility, in design of industrial and office buildings, pier sheds, warehouses, airplane hangars, water supply, and large steel roof signs. Able to direct and to work independently. References. Available at once. C-1833.

Construction Superintendent; M. Am. Soc. C.E; 20 years in charge of construction work, Accustomed to responsibility, purchasing materials, and handling finances. Experience covers work on railways, railway structures, bridges, docks, hydro-electric plants, irrigation structures, warehouses, industrial plants, and general building construction, including tall buildings. Experienced in foreign work. Speaks Spanish, C-4901.

Civil Engineer, Assoc. M. Am. Soc. C.E.; age 42; 18 years field; 5 years office experience covering railroads, hydro-electric, highway, bridges, buildings, sewers, mains, topographical, property surveys, concrete steel, and map drafting. New York and New Jersey license. B-1537.

RECENT BOOKS

New books, of interest to Civil Engineers, recently donated by the publishers to the Engineering Societies Library, will be found listed here. A comprehensive statement regarding the service which the Library makes available to members is to be found on pages 77 and 78 of the Year Book for 1930. The statements made regarding the books are taken from the books themselves and this Society is not responsible for them.

AIDE-MEMOIRE. By J. Claudel. 12th ed. Paris, Dunod, 1930. 2 vol., 2,296 pp., illus., diagrs., tables 9 × 5 in., cloth, 259, 60 fr.

This well-known handbook, first published in 1848, appears in a newly revised edition. Little change has been made in its scope, the principal emphasis still being upon hydraulic engineering, roads, railroads, and sanitary engineering, but there are also sections devoted to mechanics, industrial physics, steam and gas engines, and electrical engineering. A useful summary of current French practice.

APPLIED MECHANICS. By Norman C. Riggs. New York, Macmillan Company, 1930. (Engineering Science Series.) 328 pp., 9 × 6 in., cloth. $3.75.

A college textbook based on the course given to engineering students at the Carnegie Institute of Technology. A working knowledge of integral calculus is assumed. Emphasis is directed toward material of engineering interest.

APPRAISERS AND ASSESSORS MANUAL. By W. L. Prouty, Clem W. Collins, and Frank H. Prouty. New York, McGraw-Hill Book Co., 1930. 500 pp., illus., tables, 9 × 6 in., cloth. $5.00.

A guide to the valuation of land, buildings, machinery, merchandise, and personal property, especially with appraisals for purposes of taxation. Describes a wide variety of systems and methods which are in use, and contains many data on costs and depreciation.

ARROL'S REINFORCED CONCRETE REFERENCE BOOK. By Ernest A. Scott. London. E. & F. N. Spon., 1930. 283 pp., illus., tables, 9 × 6 in., bound. 16s.

The principal section of this book is devoted to regulations and specifications for the design and construction of reinforced concrete structures, based on an analysis and comparisons of the rulings and practice of the leading countries and engineering societies. Other sections give general formulas for members subject to flexure, and tables for detail designing. The treatment throughout is from the point of view of the practical designer and builder and is based, as the title indicates, on the practice of Sir William Arrol & Co.

BEITRAG ZUR FRAGE DES AUSBEULENS VON VERSTEIFTEN PLATTEN BEI SCHUBBEANSPRUCHUNG. By Edgar Seydel. (*Luftfahrtforschung*, vol. 8, No. 3.) Mün. u. Ber., R. Oldenbourg, 1930. 20 pp., diagrs., tables, 11 × 8 in., paper. 4,20 r.m.

The author develops a formula for determining the critical load of corrugated or stiffened plates subjected to compression.

BESTIMMUNG DER ROHRWEITEN VON HOCHDRUCK, Niederdruck, und Unterdruck-Dampfleitungen. By Johann Schmitz. 2nd ed., Mün u. Ber., R. Oldenbourg, 1930. 5 pp. text, 18 tables, 13 × 10 in., paper. 4,50 r.m.

These tables are conveniently arranged for determining the proper sizes of pipe for all ordinary steam-heating installations.

DER EHRENSAAL DES DEUTSCHEN MUSEUMS. By W. Exner. (*Deutsches Museum Abhandlungen und Berichte*, vol. 2, No. 2.) Berlin, V.D.I. Verlag, 1930. 64 pp., ports., 8 × 6 in., paper. 1. r.m.

A brief guide to the Hall of Honor of the Museum, with a list of the noted scientists and engineers represented; and reproductions of some of the portraits.

ENGINEERING. By Alexander Purves Gest. New York, Longmans, Green & Co., 1930. 221 pp., 8 × 5 in., cloth. $2.00.

An interesting account of Greek and Roman engineering, intended to set forth our debt to the engineers of antiquity. Their materials and methods of construction and their work as builders of aqueducts, roads, bridges, and hydraulic works, and as town planners are described briefly, in language understandable by the general reader. A useful bibliography is given.

ENGINEERING MATERIALS; THEORY AND TESTING OF MATERIALS. By Arthur W. Judge. New York, Isaac Pitman & Sons, 1930. Vol. 3. 498 pp., illus., diagrs., tables, 9 × 6 in., cloth. $6.00.

A connected general account of the theory of the strength properties of materials, intended to call attention to the importance of specifications, and the methods of testing. Among the topics discussed are the effect of temperature upon strength, modern theories of materials, fatigue strength, optical methods of determining stresses, and the testing of cast iron.

ESSAI D'HYDROGÉOLOGIE. By Ed. Imbeaux. Paris, Dunod, 1930. 704 pp., illus., maps, tables, 11 × 8 in. cloth. 297, 10 fr.

Dr. Imbeaux, in this treatise on hydrology, brings together the results of his long experience. Methods of determining the presence and amount of underground water, its quality and properties, are given, together with a survey of hydrological conditions in western Europe and the United States.

ESTIMATING CONSTRUCTION COSTS. By G. Underwood. New York, McGraw-Hill Book Co., 1930. 620 pp., illus., charts, tables, 9 × 6 in., fabrikoid. $6.00

Differs from other handbooks for estimators by its systematic use of charts. Over 400 charts are given, from which the cost of materials and labor for all ordinary construction jobs can be obtained without computation. In addition, the operations involved in work of each class are described and the details of estimating discussed. Chapters are included dealing with the transportation and handling of materials making estimates, and the prices of materials.

JOHNSON'S MATERIALS OF CONSTRUCTION. Rewritten by M. O. Withey and James Aston. Edited by F. E. Turneaure. 7th edition. New York, John Wiley & Sons, 1930. 859 pp., illus., diagrs., tables, 9 × 6 in., cloth. $6.00.

This work is so well known that nothing need be said except to indicate the changes in the new edition. The chapters on the characteristics, physical and mechanical properties, and uses of timber have been revised and rewritten to include new material on working stresses and grading rules. The methods of testing hydraulic cements have been rewritten. Revision has also been made of the chapters on mortar, concrete, portland cement products, and non-ferrous alloys. Many minor changes have been made to introduce new material, and statistical data have been revised.

OBJECTIVE TYPE TESTS IN ENGINEERING EDUCATION AS APPLIED TO ENGINEERING DRAWING AND DESCRIPTIVE GEOMETRY. By Clair V. Mann. New York, McGraw-Hill Book Co., published for Engineering Foundation, Inc., 1930. 122 pp., illus., charts, tables, 9 × 6 in., cloth. $2.75.

Presents tests in engineering drawing and descriptive geometry developed and used at the Missouri School of Mines to determine aptitudes and previous training on the part of entering students, and also to measure their classroom accomplishment. The book describes the tests and the methods of using them and gives a number of representative tests.

PETROLEUM ENGINEERING HANDBOOK, 1930. Los Angeles, Petroleum World, 1930. 495 pp., illus., diagrs., tables, 11 × 8 in., fabrikoid. $5.00.

A collection of articles which cover very fully methods and operations of petroleum production as practiced in California. Spacing of wells, methods of drilling and casing, treatment of field emulsions, pumping, repressuring, transportation, natural gasoline metering, and other topics are discussed by specialists. Numerous tables, formulas, and nomographic charts are included.

SCHUTZ DER BAUWERKE GEGEN CHEMISCHE UND PHYSIKALISCHE ANGRIFFE. By Otto Graf and Hermann Goebel. Berlin, Wilhelm Ernst & Sohn, 1930. 224 pp., illus., diagrs. tables, 10 × 7 in., paper. 20 r.m.

A review of the physical and chemical agents that affect buildings, and of methods for counteracting these effects. Stone, cement, mortar, concrete, metals, and wood are considered, as well as masonry. A great deal of practical information is brought together in convenient form.

SCHWINGUNGSTECHNIK; BD. 1; GRUNDLAGEN. DIE EIGENSCHWINGUNGEN EINGLIEDRIGER SYSTEME. By Ernst Lehr. Berlin, Julius Springer, 1930. 295 pp., illus., diagrs., 9 × 6 in., bound. 25,50 r.m.

The first volume of a series designed to discuss the question of vibration from the viewpoint of the practical engineer and machine builder, without the use of higher mathematics. This volume is devoted to general principles and simple cases.

WILLIAM L. SIBERT, THE ARMY ENGINEER. By Edward B. Clark. Philadelphia, Dorrance & Co., 1930. 206 pp., illus., ports., 9 × 6 in., cloth. $2.50.

General Sibert has had a long, honorable career as an officer and an engineer. This life describes his engineering work in the Philippines, in charge of the Ohio river improvements, and in the building of the Gatun locks and dam, and the Mobile ocean terminal. His activities as director of the Chemical Warfare Service during the World War and as Chairman of the Boulder Dam Board are also presented.

THE STADIUM. By Myron W. Serby. New York, American Institute of Steel Construction, 1930. 64 pp., illus., diagrs., tables, 9 × 6 in., cloth. $1.50.

Contains much practical advice on the design, construction, and equipment of steel stadiums, which will prove decidedly useful to engineers faced with those problems. The costs of many stadiums are given, and there is a useful bibliography.

DER STAHLBEHÄLTERBAU. By E. Kottenmeier. Berlin, Wilhelm Ernst & Sohn, 1930. 55 pp., illus., diagrs., 10 × 7 in., paper. 3,20 r.m.

This pamphlet contains a good account of steel tank construction. The development of present types is discussed, with descriptions of oil tanks, silos, gas tanks, and water towers. Methods of design are discussed at some length. Numerous photographs illustrate the text.

STRENGTH OF MATERIALS, PT. 1; ELEMENTARY THEORY AND PROBLEMS. By S. Timoshenko. New York, D. Van Nostrand Co., 1930. 368 pp., diagrs., tables, 9 × 6 in., cloth. $3.50.

The increasing size and cost of structures make it ever more necessary for the designer to seek the design which will give the requisite strength and reliability with the greatest possible saving in material. The purpose of this book is to show ways of applying analytical methods toward these ends. The present volume contains chiefly material usually given in the required courses in strength of materials. Attention is focused on the practical applications of the subject, the aim being to correlate studies of the strength of material and engineering design as fully as possible.

TRANSPORTATION ON THE GREAT LAKES. Issued by the Board of Engineers for Rivers and Harbors of the War Department and the Bureau of Operations of the United States Shipping Board. Rev. ed. Washington, D.C., Government Printing Office, 1930. $1.50.

General description of commerce and shipping, with special study of important traffic commodities. Data concerning lake port facilities, terminal charges, and cost of transportation.

DIE WASSERBEWEGUNG UND INFIZIERUNG IN ZWEISTÖCKIGEN FRISCHWASSERKLÄRANLAGEN. By Wilhelm Reinhart. (*Beihefte zum Gesundheits-Ingenieur, Reihe 2, No. 10.*) Mün. u. Ber., R. Oldenbourg, 1930. 50 pp., illus., 16 plates, 12 × 9 in., paper. 13,50 r.m.

Using model tanks, the author has made a thorough investigation of the phenomena that occur in sewage in septic tanks. Especial attention is given to the flow of the sewage, and the various factors that influence it. A number of principles are established that are important to builders and operators.

WIND STRESSES IN BUILDINGS. By Robins Fleming. New York, John Wiley & Sons 1930. 193 pp., illus., diagrs., tables, 9 × 6 in., cloth. $3.50.

A summing up of the author's writings upon wind stresses during the past seventeen years. Beginning with a study of the wind, the book discusses hurricanes and tornadoes, wind pressure and wind velocity, wind stresses in steel mill buildings and many-storied buildings, and the design of details in tall buildings. Stress sheets and diagrams of the wind bracing of a 53-story building are given. A chapter is added on earthquakes and earthquake resistance.

CURRENT PERIODICAL LITERATURE

Abstracts of Articles on Civil Engineering Subjects from Magazines in This Country and in Foreign Lands

Selected items from the current Civil Engineering Group of the Engineering Index Service, 29 West 39th Street, New York, N.Y. Every article indexed is on file in The Engineering Societies Library, one of the leading technical libraries of the world. Some 1,800 technical publications are received by the Library and are read, abstracted, and indexed by trained engineers. With the information given in the items which follow, you may obtain the article from your own files, from your local library, or direct from the publisher. Photoprints will be supplied by this Library at the cost of reproduction, 25 cents per page, or technical translations of the complete text may be obtained when necessary at cost.

BRIDGES

CONCRETE ARCH, CONSTRUCTION. Winter Construction of Concrete Bridges on Ohio River Boulevard, V. R. Covell and P. J. Freeman. *Eng. News-Rec.*, vol. 105, no. 13, Sept. 25, 1930, pp. 482–485, 4 figs. Winter expedients and use of high-early-strength cement expedite completion of $5,000,000-boulevard with nine bridges, in Alleghany County, 220 days ahead of scheduled date; forms and centering for arch ribs and spandrel columns; winter costs and savings.

DESIGN. Aesthetics in Metal Bridge Designs, W. N. Elgood. *Engineer* (*Lond.*), vol. 150, no. 3895, Sept. 5, 1930, pp. 256–257. Factors which govern aesthetics; arch, cantilever, and suspension structures usually possess poetic and artistic grace, and consequently lines of respective designs do not require modification.

General Data for Bridge Projects (Generalidades para el proyecto de Puentes), M. Marroquin. *Revista Mexicana de Ingenieria y Arquitectura* (*Mexico, D.F.*,) vol. 8, no. 7, July 15, 1930, pp. 361–370. Discussion of preliminary studies, selection of type, and detailed structural project.

HIGHWAY, AUSTRALIA. The Big River Bridge at Mansfield, Victoria, M. G. Dempster. *Commonwealth Engr.* (*Melbourne*), vol. 17, no. 12, July 1930, pp. 448–451, 3 figs. Report on construction of steel girder highway bridge, consisting of six spans each 40 ft. long, with red gum timber deck 15 ft. wide; concrete chosen for abutments and piers; cost 45,000 pounds sterling.

HIGHWAY, GERMANY. Four New Highway Bridges Over the Aller River (Vier neue Strassenbruecken ueber die Aller), Juergens and Huch. *Zentralblatt der Bauverwaltung* (*Berlin*), vol. 50, no. 34, Aug. 27, 1930, pp. 600–605, 13 figs. Features of bridges built of concrete and steel trusses with single spans up to 43 meters in length; details of bridge bearings.

HIGHWAY, STOCKHOLM. Competitive Design for Vaester Bridge in Stockholm (Idetaevlingen om Vaesterbron i Stockholm), K. Ljungberg. *Teknisk Tidskrift* (*Stockholm*), vol. 60, no. 30, July 26, 1930, (Vag-och Vattenbyggnadskonst) pp. 85–94 and (discussion) 94–97, 14 figs. One of prize-winning designs in contest for design of highway bridge in Sweden is described in detail.

KILL VAN KULL. The Substructure of Kill Van Kull Bridge, New York. *Engineering* (*Lond.*), vol. 130, no. 3371, Aug. 22, 1930, pp. 227–228, 26 figs. partly on p. 236 and supp. plates. Substructure comprises abutments for arch span, and piers for approaches; two abutments of concrete and granite masonry, founded upon bedrock, were constructed by use of coffer-dams and with floating plant equipment; approach piers are of reinforced concrete and consist of shafts, founded upon footings, which rest on bedrock for some piers and on gravel for others.

STEEL CONSTRUCTION. Guy-Derrick Erection of Steel Bridges and Viaducts. *Eng. News-Rec.*, vol. 105, no. 9, Aug. 28, 1930, pp. 318–323, 8 figs. Report on record-time erection of long cantilever bridge at Louisville and deck-truss and deck-girder structure on new line of Pittsburgh & West Virginia Railway; lightness, low cost, and ability to start job at any pier are among advantages over erection-traveler method; step by step utilization of guy derricks for erecting bridge; details of 20-ton guy-derrick traveler at Louisville; method of moving guy derricks in erecting deck-truss and girder viaducts.

STEEL TRUSS, MONTREAL. The Montreal-South Shore Bridge Over the St. Lawrence River. *Eng. and Contracting*, vol. 60, no. 9, Sept. 1930, pp. 330–336, 11 figs. Article based on paper by L. R. Wilson, presented before Eng. Inst. of Canada, previously indexed from Eng. Jl. (Montreal), Jan. 1930.

STEEL TRUSS, VANCOUVER. Large Bridge, 2,817 Ft. Long, to Be Built in Vancouver. *Contract Rec.* (*Toronto*), vol. 44, no. 37, Sept. 10, 1930, p. 1085. Features of projected steel-truss highway bridge, with individual spans up to 295 ft. 5 in. in length.

STEEL, WELDING. Recent Welded Bridges (Neuere geschweisste Bruecken), R. Bernhard. *V.D.I. Zeit.* (*Berlin*), vol. 74, no. 35, Aug. 30, 1930, pp. 1201–1207, 23 figs. Report on design and construction practice followed in three recently completed steel-truss and plate-girder bridges, in Switzerland and Germany, from 10 meters to 52 meters in length; welding details and features of equipment used; description of X-ray equipment used in testing of completed welds.

SUSPENSION, FLOORS. Paving the Roadway of the Mid-Hudson Bridge. *Construction Methods*, vol. 12, no. 9, Sept. 1930, pp. 32–36, 18 figs. Report on paving of concrete roadway of 3,000-ft. Mid-Hudson suspension bridge between Poughkeepsie and Highland, N.Y.; planned sequence of slab-concreting operations equalizes dead load on bridge cables.

SUSPENSION, GERMANY. The New Suspension Bridge Across the Rhine at Cologne, H. Seidel. *Eng. Progress* (*Berlin*), vol. 11, no. 9, Sept. 1930, pp. 232–236, 7 figs. Bridge, opened for traffic in October 1929, is largest suspension bridge in Europe, having span of 1,040 ft.; superstructure is described in some detail.

SUSPENSION, GOLDEN GATE. Golden Gate Bridge for San Francisco Bay. *West. Construction News*, vol. 5, no. 17, Sept. 10, 1930, pp. 420–423, 5 figs. Abstract of final report made on suspension bridge with 4,200-ft. main span; $35,000,000 bond issue prepared; field studies; bridge design.

SUSPENSION, HUDSON RIVER. Constructing the Hudson River Bridge, F. W. Skinner. *Can. Engr.* (*Toronto*), vol. 59, no. 8, Aug. 19, 1930, pp. 249–252, 5 figs. Comparative long-span types; development of suspension bridges; preliminaries to building Hudson River bridge; cable-wire manufacture and spinning. Paper read before Eng. Inst. of Canada.

TESTING BRIDGE PIERS. The Effect of a Natural Stone Casing upon the Strength of Concrete Piers (Der Einfluss einer Natursteinverkleidung auf die Festigkeit von Betonpfeilern), Gaber. *Beton u. Eisen* (*Berlin*), vol. 29, no. 16, Aug. 20, 1930, pp. 296–301, 10 figs. Report on laboratory test of model of concrete pier of Cologne-Muelheim Bridge over Rhine River; comparison of strength of encased and non-encased concrete piers.

WOODEN, BRITISH COLUMBIA. The Fraser River Bridge—Quesnel, B.C., P. Philip. *Am. Wood Preservers Assn.*, 1930, pp. 255–261 and (discussion) 261–266, 2 figs. Bridge consists of five through Howe truss spans: two 150-ft. shore spans and three 180-ft. central spans; all timbers were creosote treated.

BUILDINGS

APARTMENT HOUSES, ATLANTIC CITY, N.J. Welded Concrete Masonry Back-Up Walls in Apartment Building, L. H. Doane. *Concrete*, vol. 37, no. 3, Sept. 1930, pp. 27–29, 7 figs. Use of "weldcrete" masonry construction in 10-story Riviera Apartments at Atlantic City; cement gun fills open joints and coats faces of concrete masonry units laid dry, "welding" wall into monolithic mass; cost data; detail of composite wall of cinder units and gunite.

CONSTRUCTION MATERIALS. Steel vs. Reinforced Concrete in Construction of High Buildings (Stahl oder Eosenbeton im Hochhausbau), R. Frab. *Montanistische Rundschau* (*Vienna*), vol. 22, no. 14 (Supp.), July 16, 1930, pp. 49–50. Relative merits of two building materials are compared, and conclusion is reached that steel construction is preferable.

HOTELS, AIR CONDITIONING. Modern Air-Conditioning Systems Increase Patronage of Older Hotels, H. L. Branigan. *Heat., Piping and Air Conditioning*, vol. 2, no. 9, Sept. 1930, pp. 748–749, 1 fig. Description of air-conditioning apparatus installed in Hotel Sinton, Cincinnati, Ohio; main air supply; temperature and humidity control; saving through recirculation.

PIPE JOINTS, WELDED. Pipe Welding in Buildings, C. Kandel and C. M. Whalen. *Welding Engr.*, vol. 15, no. 9, Sept. 1930, pp. 55–57, 3 figs. Increasingly large number of buildings of major size are using welded pipe joints for wide range of service, as recent New York survey shows.

SCHOOL BUILDINGS, AIR CONDITIONING. Control of Air Conditions in School Buildings, J. Howatt. *Heat. and Vent.*, vol. 27, no. 9, Sept. 1930, pp. 86–89, 4 figs. Discussion of air conditioning with special reference to health, comfort, and effect of temperature on classroom work; design and layout of equipment in various types of heating and ventilating systems.

Suggestions for Improving Schoolroom Air Conditions, T. J. Duffield. *Heat and Vent.*, vol. 27, no. 9, Sept. 1930, pp. 90–92 and 112, 5 figs. Practical discussion of means of improving air-conditioning systems; air distribution; temperature control.

STEEL FRAME, DESIGN. Practical Notes on the Checking of Steelwork Design in Buildings, J. Clapp. *Surveyor* (*Lond.*), vol. 78, no. 2011, Aug. 8, 1930, pp. 139–140, 4 figs. Notes for facilitating rough checking of sizes of main girders, stanchions, etc.; symmetrical and unsymmetrical loadings; short method of obtaining position of maximum B.M.

Practical Notes on the Checking of Steelwork Design in Buildings, J. Clapp. *Surveyor* (*Lond.*), vol. 88, no. 2014, Aug. 29, 1930, pp. 211–214, 7 figs. Example with unsymmetrical loading; continuous beams; curved beams and girders; long stanchions; grillages; lattice girders; plate girders. (Concluded.)

STEEL WELDING. Welding Steel Structures. *Eng. News-Rec.*, vol. 105, no. 12, Sept. 18, 1930, pp. 442–449, 5 figs. Symposium of six articles: Highest All-Welded Office Building Erected in Dallas; Inspecting Field-Welding of Structural Steel, W. F. Carson; Rational Method of Welded Connection Design, A. Vogel; Large Area of Welded Steel Floor in Pittsfield, Mass., Garage, E. N. Adams; Welding Field Joints on 14-Story Office Building, J. T. Whitney; Arc-Welding Facts That Should Be Common Knowledge.

CONCRETE

CONSTRUCTION, PNEUMATIC PLACING. Reinforcing Structures with Gunite, J. F. Salmon. *Can. Engr.* (*Toronto*), vol. 59, no. 10, Sept. 2, 1930, pp. 281–283, 5 figs. Report, by Canadian National Railways, on development of guniting method of reinforcing and beautifying; guniting piers of Humber River Bridge; essentials of successful guniting.

CONSTRUCTION INDUSTRY

COSTS. Unit Bid Summary. *West Construction News*, vol. 5, no. 17, Sept. 10, 1930, pp. 42–44, 46, and 48. Compilation of unit cost bids on street and road works, river and harbor works; irrigation and reclamation structures; sewer construction, bridge, and culvert construction in California and other Western States.

STRUCTURAL STEEL WELDING. Welding of Structural Steel Requires Understanding, F. P. McKibben. *Steel*, vol. 87, no. 12, Sept. 18, 1930, pp. 60 and 62. Elementary and fundamental features of arc welding as applied to ordinary steel building construction in form of questions and answers.

WELDING SPECIFICATIONS. Welding and the Building Codes, F. P. McKibben. *Welding*, vol. 1, no. 11, Sept. 1930, pp. 739–744 and 747, 6 figs. Survey of building-code regulations pertaining to welding in United States and qualification tests of welders; data on specification for physical properties of welds.

DAMS

ARCH, DESIGN. Design Features of High Arch Dams, F. Vogt. *Can. Engr.* (*Toronto*), vol. 59, no. 11, Sept. 9, 1930, pp. 303–306. Fundamental views in analysis of arch dams; elastic

properties of concrete; elastic deformation in foundation; direct water load on canyon; stresses in cross section; external loads on dams; transfer of heat in concrete; periodical changes in temperature. From paper presented at Second World Power Conference, Berlin. (To be continued.)

CONCRETE, SALT RIVER, ARIZ. Organization, Equipment, and Methods, J. S. Connell. *Contractors and Engrs. Monthly*, vol. 21, no. 2, Aug. 1930, pp. 55–60, 5 figs. Report on construction of Stewart Mountain dam and power plant on Salt River irrigation project, in Arizona; total height of dam from deepest bedrock 212 ft.; dam is partly of arch and partly of gravity section; description of construction camp, concreting camp, foundation excavation, etc.

CONSTRUCTION, CRUSHED STONE PLANTS. Crushing and Grinding Plant at the Esla Dam in the Province of Tamora, Spain (Die Brech und Mahlanlage der Esla Talsperre, Provinz Tamora, Spanien), A. Bonwetsch. *V.D.I. Zeit.* (*Berlin*), vol. 74, no. 35, Aug. 30, 1930, pp. 1211–1214, 16 figs. Layout and equipment of crushing plant for granite rock with individual pieces up to 1 ton in weight, having hourly output of 2,000 cu. m.; description of roller mills having capacity of 30 cu. m. per hr.; design of conveyor system having total length of 380 c. with inclines up to 35 per cent.

GRAVITY, ANCHORS. Improvement of Gravity Dams by Means of Steel Anchoring Rods (Perfectionnements aux barrages-poids par l'adjonction de tirants en acier), A. Coyne. *Génie Civil* (*Paris*), vol. 97, no. 8, Aug. 23, 1930, pp. 186–187, 3 figs. Author proposes use of extension rods imbedded to depth of about 10 meters in bedrock, under dam foundation, and extending as far as top of dam; analysis of effects such system of reinforcement might have on stability of Assuan Dam, Egypt, and Cheurfas Dam, Algeria.

HYDRAULIC FILL. Earth Dams Built by Hydraulic Process (presas de tierra construidas por procedimiento hidraulico), J. L. Gomez Navarro. *Revista de Obras Publicas* (*Madrid*), vol. 78, nos. 2553 and 2554, July 15, 1930, pp. 343–347 and Aug. 1, pp. 366–370, 16 figs. July 15: Principle and technic of building hydraulic-fill dams; tabular data on location and heights of 21 such dams in United States, Puerto Rico, and Panama. Aug. 1: Notes on Cobble Mountain and Saluda dams, derived largely from articles indexed in Engineering Index 1929, p. 549.

RESERVOIRS, SILT REMOVAL. Removal of Silt from the Lete Reservoir (Nota sul lavoro di sfangamento del bacino del Lete), L. Selmo. *Energia Elettrica* (*Milan*), vol. 7, no. 6, June 1930, pp. 515–519, 10 figs. Report on removal of silt deposits by hydraulic method, from bottom of reservoir serving hydro-electric plant; silt accumulation interfered with discharge from regulating valve at heel of dam.

SAFETY. Building Code for Dams, M. H. Gerry, Jr. *West. Construction News*, vol. 5, no. 17, Sept. 10, 1930, pp. 440–442. Thoughts on some uncertainties in dam design, with remarks on wisdom of providing ample margin of safety; foundations; concrete in dams; vibrations.

SPILLWAYS, GATES. Large Spillway gates at Hume Dam. *Commonwealth Engr.* (*Melbourne*), vol. 17, no. 12, July 1930, pp. 439–442, 4 figs. Description of series of 29 gates of overshot type, 15 ft. 8 in. deep and 22 ft. wide, built of heavy rolled steel joists with mild steel plates riveted on downstream side and vertical tie plates attached on reverse side; continuous caterpillar roller trains running in grooved facings at each side of gate.

STORAGE RESERVOIRS. Eleven-Mile Canyon Reservoir Permits Denver to Use Full Storage of Lake Cheesman, D. D. Gross. *Eng. News-Rec.*, vol. 105, no. 11, Sept. 11, 1930, pp. 425–426, 2 figs. Features of proposed storage project including arched dam 112 ft. high, containing 50,000 cu. yd. of concrete; map of storage and sources of water on South Platte River above Denver and irrigated areas.

STORAGE RESERVOIRS, GREAT BRITAIN. Bartley Reservoir. *Water and Water Eng.* (*Lond.*), vol. 32, no. 380, Aug. 20, 1930, pp. 363–365, 3 figs. Discussion of new storage reservoir for Birmingham water supply, formed by earth embankment of 65 ft. maximum height; reservoir has net effective capacity of 501,000,000 gal.

UPLIFT PRESSURE. Uplift Pressure in Gravity Dams, I. E. Houk. *West. Construction News*, vol. 5, no. 14, July 25, 1930, pp. 344–349, 3 figs. Discussion of allowances for uplift in design of gravity dams; measurements at existing dams; maximum observed uplift pressure under existing gravity dams on rock foundations; effect of grouting and draining; effect of variations in uplift pressure on location of resultant; effect of uplift on factor of safety against failure by sliding; effect of uplift on concrete stress.

FLOOD CONTROL

LEVEES, HYDRAULIC FILL. Levee Building with Hydraulic Dredges on the Mississippi, L. Brown. *Eng. News-Rec.*, vol. 105, no. 9, Aug. 28, 1930, pp. 342. Chief of Engineers, U.S. Army, discusses fundamentals of hydraulic dredging methods and their use for flood control and navigation construction on Mississippi River.

NEW ENGLAND. Report of the Committee on Floods, March 1930. *Boston Soc. Civil Engrs.—Jl.*, vol. 17, no. 7, Sept. 1930, pp. 285–464, 36 figs. Study of 1927 flood in New England; flood damage; previous great storms in New England, 1770 to 1927; flood factors for New England; rainfall-run-off relations; drainage area characteristics.

FLOW OF FLUIDS

FLOW OF LIQUIDS. Interruption Phenomena in Streams of Viscous Liquids (Zerreisserscheinungen in Stroemungen zaeher Fluessigkeiten), M. Lagally. *Zeit. fuer Angewandte Mathematik und Mechanik* (*Berlin*), vol. 10, no. 2, Apr. 1930, pp. 137–141, 4 figs. Theoretical mathematical discussion of tensile stresses in uniform streams flowing in cylindrical and flat-bottom channels; equations of conditions leading to interruption of stream.

PIPES. Modern Measurements of Pressure Loss in Pipes and Law of Surface Friction with Large Reynolds Coefficients (Die neueren Messungen des Druckverlustes in Rohren und das Gesetz der Oberflaechenreibung bei grossen Reynoldsschen Zahlen), H. Lerbs. *Werft Reederie Hafen* (*Berlin*), vol. 11, no. 17, Sept. 7, 1930, pp. 365–367, 6 figs. Nikuradse's new measurements of pressure loss in pipe are used to develop law of surface friction based on generalization of Karman's calculation of law of Blasius; brief contribution by F. Eisner is appended.

FOUNDATIONS

BRIDGE PIERS. Corrugated Steel Shells in Bored Holes Form New Type Pier Foundations on P. R. R. Bridge. *Eng. News-Rec.*, vol. 105, no. 10, Sept. 4, 1930, pp. 366–368, 6 figs. Description of novel method of sinking wells, 80 ft. deep, through Hackensack meadow muck for approach piers of passenger line crossing over Hackensack River; combination open and pneumatic corrugated steel shells of 48-in. and 54-in. diameter, sunk in bored holes belled out to 11 ft. and 12 ft. 3 in. at bottom; detail of piers, boring auger, shaft, muck locks on shells.

BUILDING REPLACEMENT. Foundation of Fourteen-Story Building Replaced under Basement Floor. *Eng. News-Rec.*, vol. 105, no. 13, Sept. 25, 1930, pp. 496–499, 5 figs. Report on transferring 14-story building in San Francisco from foundation of 1,100 wooden piles to 210 concrete piers, without disturbing tenants of building or causing any appreciable settlement; hydraulic jacks place load on needle beams; foundation plan, showing footings, caissons, and connecting beams.

LIGHTHOUSES. Foundations for Large Lighthouses in Open Sea (Underbyggnad for stora fyrar i oppen sjo), H. Lenander. *Teknisk Tidskrift* (*Stockholm*), vol. 60, no. 34, Aug. 23, 1930, (Vag och Vattenby ggnadkonst), pp. 106–109, 6 figs. Construction of several big lighthouses in Sweden and Denmark is described, giving main dimensions and cost of construction. (To be continued.)

HYDRO-ELECTRIC POWER PLANTS

DEVELOPMENTS, ALBERTA. Ghost Hydro-Electric Power Project, H. J. McLean. *Can. Engr.* (*Toronto*), vol. 59, no. 8, Aug. 19, 1930, pp. 241–245, 7 figs. Description of recently completed power development near confluence of Ghost and Bow Rivers, Alberta; dam, nearly 5,000 ft. long, consists of concrete, earth-fill, and semi-hydraulic fill sections; methods of construction.

DEVELOPMENTS, TEXAS. Huge Irrigation Project in Texas Embodies Many Unique Features, A. Callan. *Mfrs. Rec.*, vol. 98, no. 10, Sept. 4, 1930, pp. 48–50, 4 figs. Brief account of project by which water is to be diverted from Rio Grande River, 40 miles above Eagle Pass, and used for developing hydro-electric power and irrigating 70,000 acres; main canal to total 88 miles; to generate 12,000 hp.

INTAKES. Damming, Blowing, and Sealing in Crib-House Construction, C. C. Moody. *Concrete*, vol. 37, no. 2, Aug. 1930, pp. 13–16, 4 figs. Extension of intake on $15,000,000 power project in Central Illinois, involving placing of concrete in 25 ft. of water; use of tremie in cramped quarters; how tremie was sealed; stopping leak under high-pressure head.

IRRIGATION

CONSTRUCTION EQUIPMENT OF CANALS. New Machines Developed for Work on Irrigation Ditches. *Eng. News-Rec.*, vol. 105, no. 13, Sept. 25, 1930, pp. 501–502, 3 figs. Description of excavator digging 8-ft. ditch for $600 per mile; also of efficient ditch cleaner devised by Imperial Irrigation District.

MATERIALS TESTING

DURABILITY OF STRUCTURAL STEEL. Waldorf-Astoria Steel Is Found Well Preserved, F. H. Frankland. *Steel*, vol. 87, no. 10, Sept. 4, 1930, pp. 50–52. Discussion of test results obtained with samples from Waldorf-Astoria building; table gives physical properties and composition of steel from various parts of building.

STEEL, COLD WORKING. Cold Rolling Raises Fatigue or Endurance Limit, G. S. von Heydekampf. *Iron Age*, vol. 126, no. 12, Sept. 18, 1930, pp. 775–777 and 829, 4 figs. Investigation of endurance limits and elastic behavior with special attention to mechanical hysteresis effect for ranges of stress within elastic and fatigue limits; influence of surface and surface damage on fatigue strength; by cold rolling surface of machine parts, fatigue or endurance limit can be raised about 15 per cent.

STRENGTH. Critical Loads in Elastic Systems (Charges critiques dans les systemès élastiques), E. Marcotte. *Arts et Métiers* (*Paris*), no. 117, June 1930, pp. 242–244. Critical stresses in static systems and critical frequencies of vibration in dynamic systems are discussed on basis of studies by Timoshenko, Bryan, and Nadal, and simplified method for their determination is developed; examples of application are given.

The Statistical Elements in Mechanics of Materials, F. B. Seely. *Mech. Eng.*, vol. 52, no. 9, Sept. 1930, pp. 839–844, 9 figs. High importance of recognizing statistical element in picture of internal structure of material and of stress distribution, when interpreting mathematical and experimental results and formulating more reliable rules for design. Presented before American Association for Advancement of Science, Dec. 1929.

WELDED JOINTS, STRESSES. Stress Distribution in Side-Welded Joints, W. H. Weiskopf and M. Male. *Am. Welding Soc.—Jl.*, vol. 9, no. 9, Sept. 1930, pp. 23–48, 17 figs. Three new features in connection with side-welded joints: theory as to manner in which welds deform under shearing loads; means of determining effective areas of bars composing such joint; method of determining length of welds, so that maximum shear stress will not exceed average design stress by more than any desired ratio.

WELDS. Fatigue and Impact Tests for Welds, C. H. Jennings. *Am. Welding Soc.—Jl.*, vol. 9, no. 9, Sept. 1930, pp. 90–104, 13 figs. Need of fatigue tests and problems encountered in making them; information obtained by author on impact strength of arc welds.

Magnetic Testing of Butt Welds, T. R. Watts. *Am. Welding Soc.—Jl.*, vol. 9, no. 9, Sept. 1930, pp. 49–68, 17 figs. Magnetographic method has been employed experimentally by Research Laboratories, Westinghouse Electric and Manufacturing Company, for nearly two years.

PORTS AND MARITIME STRUCTURES

BORDEAUX, FRANCE. Improvements at the Port of Bordeaux. *Engineer* (*Lond.*), vol. 150, no. 3896, Sept. 12, 1930, pp. 270–273, 16 figs., partly on p. 282. Program provided for reconstruction of some of wharves in Bordeaux; notes on design and methods of construction.

BRIGHTON PIER, ENGLAND. Reconstruction of the New Brighton Promenade Pier. *Engineer* (*Lond.*), vol. 150, no. 3895, Sept. 5, 1930, p. 262, 2 figs. Cast-iron columns were only portions of original pier found to be in sufficiently safe state of preservation to be emodied in new structure; details of underbracing; new girders were designed to allow of equally distributed load of 1¹/₄ cwt. per sq. ft. over whole of pier.

BRITISH EMPIRE. The Economics of Port Development and Administration, G. Buchanan. *Inst. of Transport—Jl.* (*Lond.*), vol. 11, no. 9, July 1930, pp. 442–456 and (discussion) 456–458. Problems involved in providing adequate facilities; factor affecting location; means of obtaining effective administration; requirements of shippers; detailed description of representative British ports in England, India, South Africa, and Australia.

SEATTLE AND VANCOUVER. Northwest Ports Expanding Facilities, C. F. A. Mann. *Mar. Rev.*, vol. 27, no. 9, Sept. 1930, pp. 394–395, 4 figs. Important additions completed to care for heavy increase in freight and passenger movement over wharf system operated by Port of Seattle Commission; work on new $1,500,000 fishermen's pier has been started by Harbor Commission of Vancouver, British Columbia, and by the end of year Vancouver will have one of finest fishing terminals in world.

STOCKHOLM. Port of Stockholm. *Dock and Harbour Authority* (*Lond.*), vol. 10, no. 119, Sept. 1930, pp. 326–331 and 351, 20 figs.; see also editorial comment, p. 324. History of port; situation; approaches to port and connections between sea and Lake Malaren; communications by water with interior; railway connections; traffic area and conditions; port administration; shipyards, dry docks, and repairing shops. (To be continued.)

TRAINING WALLS. The Training Wall across the Liao Bar in Manchuria, P. N. Fawcett. *Assn. of Chinese and Am. Engrs.—Jl.* (*Peiping*), vol. 11, no 7, July 1930, pp. 23–36, 5 figs. Problems in harbor work encountered at Port of Niuchuang in Southern Manchuria.

RAILROADS, STATIONS, AND TERMINALS

PENNSYLVANIA. Pennsylvania Railroad Building New Terminal in Philadelphia, R. G. Skerrett. *Compressed Air Mag.*, vol. 35, no. 8, Aug. 1930, pp. 3222–3227, 18 figs. Illustrated description of construction work of new station; construction equipment; rock drilling operations.

SWEDEN. Centralizing the Railway Service in Gothenburg (Centralisering av Jaernvaegstrafiken i Goeteborg), T. A. Toerjeson. *Teknisk Tidskrift* (*Stockholm*), vol. 60, no. 32, Aug. 9, 1930, pp. 466–470, 6 figs. Two terminals used as both passenger and freight stations for five railroad lines are reconstructed so that one terminal now serves only as passenger station and the other only as freight terminal; work undertaken by Swedish State Railway costs 9,263,000 Swedish Krones.

ROADS AND STREETS

ASPHALT PAVEMENTS. Cold Laid Asphalt Pavements, A. W. Dow. *Engrs. and Eng.*, vol. 47, no. 6, June 1930, pp. 150–155, and (discussion) 155. Types of pavements discussed are: rock asphalt, amiesite type, cutback asphalt binders, emulsified asphalt binders, colprovia type, and macasphalt type.

BRICK PAVEMENTS, FILLERS. Requirements for Asphalt Filler for Brick Pavements, H. W. Skidmore. *Nat. Paving Brick Mfrs. Assn.—Proc.*, for mtg. Dec. 4–6, 1929, pp. 54–58 and (discussion) 58–61, 5 figs. Article previously indexed from Good Roads, Mar. 1930.

CEMENT CONSTRUCTION. Quick-Hardening Cement Simplifies Detour Problem. *Eng. News-Rec.*, vol. 105, no. 9, Aug. 28, 1930, p. 336, 2 figs. Mountain districts in North Carolina, where detours are difficult, keep traffic moving by using special cement; pavement is laid in two strips, forms are set for first half-width strip, which is poured while traffic is maintained over fill on other half of roadway; in 36 hours traffic is turned over first half-width strip and second strip is poured.

CONCRETE CONSTRUCTION. Mixing Cycle and Production in Concrete Paving Work, A. P. Anderson. *Roads and Streets*, vol. 70, no. 9, Sept. 1930, pp. 305–309, 5 figs. Discussion of data from intensive study of field records of over a hundred going jobs; effect of length of mixing cycle on rate of actual production and total crew used; average operating characteristics of paver working under 60-sec. mixing time; effect of mixing time on strength of concrete; time losses on average concrete paving job.

CONCRETE PAVEMENTS, BETHLEHEM, PA. Keeping Ahead of the Times in Paving Practice, *Concrete*, vol. 37, no. 2, Aug. 1930, pp. 22–24, 2 figs. City of Bethlehem, Pa., combines research and construction in practical way; new ideas thoroughly tested before adoption; limestone screenings as fine aggregate; careful field inspection; detail of reinforced-concerte paving standard sheet; results of absorption tests.

CONSTRUCTION, SWAMPS. Difficult Work on Highway Fill in Muck-Bottom Lake. *Eng. News-Rec.*, vol. 105, no. 9, Aug. 28, 1930, pp. 329–330, 4 figs. Report on building 1,600-ft. fill on 5 to 25 ft. of soft muck under water 5 to 10 ft. deep, underlaid by clay and lignite coal, in replacing trestle approaches to 125-ft. highway swing bridge across Upper des Lacs Lake near Bowbells, N. D.; placing and settling of material; muck forced up like island; mattress and rock revetment.

DESIGN. Layout and Construction of Roads, C. H. Bressey. *Surveyor* (*Lond.*), vol. 78, no. 2102, Aug. 15, 1930, pp. 163–164. Full text of memorandum on layout and construction of roads, prepared by officers of Ministry of Transport in collaboration with representatives of Institution of Municipal and County Engineers and of County Surveyor's Society; amenities, acquisition of land, line of road, carriageway, service roads, visibility and curves, super-elevation, gradient, footways, fencing at road junctions, curbs, road crossings, obstructions, bridges, warning signs, and specifications.

Load, Road, and Subgrade, C. A. Hogentogler and C. Terzaghi. *Good Roads*, vol. 73, no. 8, Aug. 1930, pp. 298–299 and 305–306. Discussion of precautionary measures for types of subgrades; subgrade support; drainage surface, and subgrade treatments; base courses; pavement design.

FOUNDATIONS. Foundations for Asphalt Pavements, A. T. Goldbeck. *Engrs. and Eng.*, vol. 47, no. 6, June 1930, pp. 161–167, 1 fig.; see also *Crushed Stone Jl.*, vol. 6, no. 7, July 1930, pp. 6–12. Traffic loads; concrete-base design to resist traffic for durability, and for effect of asphalt wearing surface; macadam of gravel base; black base; subgrade and drainage; trends in present practice.

MACADAM. Penetration Macadam Designs and Methods of Construction, C. L. Woolley. *Good Roads*, vol. 73, no. 8, Aug. 1930, pp. 288–289 and 292, 294. Discussion of basic principles and requirements; precautionary measures; rules for handling.

PAVEMENT OF BRIDGE HIGHWAY. Quebec Bridge Roadway Construction, J. Jobin. *Can. Engr.* (*Toronto*), vol. 59, no. 9, Aug. 26, 1930, pp. 261–264, 9 figs. Report on construction of concrete roadway 15 ft. 2 in. wide; road floor system composed of 8-in. I-beams as stringers resting on top flanges of floor beams; flooring consists of reinforced-concrete slab resting on stringers; construction of approaches; expansion joints; preparation of foundations for concrete wall.

TESTING ROAD MATERIALS. The Results of Physical Tests of Road-Building Rock, D. O. Woolf. *U. S. Dept. of Agriculture—Miscellaneous Pub.*, no. 76, July 1930, 148 pp. Results of tests of 6,000 samples of ledge rock, made by Bureau of Public Roads prior to January 1, 1928, classified alphabetically according to location, representing road-building material from practically all parts of United States.

SEWERAGE AND SEWAGE DISPOSAL

CHLORINATION. Sewage Chlorination for the Protection of Masonry Sewers Against Disintegration, L. H. Enslow. *Water Works and Sewerage*, vol. 77, no. 9, Sept. 1930, pp. 306–308, 4 figs. Role of bacteria in disintegration of sewers; intermittent chlorination will suppress biological activity and prevent trouble; experiences in Orange County, Calif., show effectiveness of chlorine. Bibliography.

FILTERS. Trickling Filters, J. R. Downes. *Water Works and Sewerage*, vol. 77, no. 9, Sept. 1930, pp. 313–315. Evolution of trickling filters; effect of preparatory treatment, clogging, odors, filter flies; getting best possible results from trickling filters.

PLANTS, BERLIN. Sanitation of Berlin (El Saneamiento de Berlin), R. Montalban. *Revista de Obras Publicas* (*Madrid*), vol. 78, no. 2556, Sept. 1, 1930, pp. 409–414, 11 figs. Wassmansdorff purification station, for treatment of sewage from Schoeneberg and Neukoelln zones, with population of 560,000; flow is about 80,000 cu. m. daily in dry season and double that in wet season; Emscher tanks; recovery of combustible gases.

PLANTS, FLINT, MICH. Operation of Flint Sewage Treatment Plant in 1929. *Pub. Works*, vol. 61, no. 8, Aug. 1930, pp. 24–26, 3 figs. Results obtained during second year of operation; circulation of sludge reduces foaming in Imhoff tanks; improvements in sludge drying; experiments in odor control; average and analysis of raw sewage and tank effluent; comparison of sewage analysis and plant efficiencies.

SLUDGE DIGESTION. Factors in Sludge Digestion, M. Lundie. *Surveyor* (*Lond.*), vol. 78, no. 2012, Aug. 15, 1930, pp. 165–167. Review of principle factors and outline of research work done; temperature; reaction control, meaning of pH scale; solids concentration; age of solids for digestion; seeding digestion of sludge to completion Pretoria experiences in partial digestion; improvements in scum arrangements for sedimentation tanks. Paper presented before Instn. Mun. and County Engrs.

STRUCTURAL ENGINEERING

CONCRETE AND STEEL. Steel Cellular-Floor Construction (Stahlzellendecke). *Zentralblatt der Bauverwaltung* (*Berlin*), vol. 50, no. 19, May 14, 1930, pp. 358–359, 5 figs. Corrugated steel units described are intended to replace more usual hollow tiles in concrete-floor construction; each weighs about 9 lb.

EARTHQUAKE-RESISTING STRUCTURES. Engineering Data Needed on Earthquake Motion for Use in the Design of Earthquake-Resisting Structures, John R. Freeman. *Bulletin, Seismological Society of America*, vol. 20, no. 2, June 1930. Presentation of data about earthquake motion to promote study of methods of earthquake stress analysis.

HIGH BUILDINGS. Wind Bracing; The Importance of Rigidity in High Towers, H. V. Spurr. N.Y., McGraw-Hill Book Co., 1930, 132 pp., diagrs., $3.00. Description of features of wind bracing; development of fundamental principles of design and application to problems of designer.

STEEL FRAME BUILDINGS. Notes on the Bracing of Steel-Framed Buildings, W. Smith. *Structural Eng.* (*Lond.*), vol. 8, no. 9, Sept. 1930, pp. 330–339, 15 figs. Discussion of methods of bracing of various types of structures; rafter girder; horizontal girder at tie level; continuous tie angles at tie level; crane girders; tie joists; vertical bracings.

STEEL SPECIFICATIONS. Structural Steel for Bridges, Etc., and General Building Construction. *Brit. Eng. Standards Assn.*—Standard Specification (Lond.), no. 15, May 1930, pp. 5–20, 8 figs. Specifications cover process of manufacture, tensile test, cold bend tests, inspection, etc.

STRESSES. The General Equation of Stress in Frictional-Cohesive Material, R. W. H. Hawken. *Instn. Engrs. Australia—Jl.* (*Sydney*), vol. 2, no. 7, July 1930, pp. 247–257, 14 figs. Author propounds and solves general theorem of stress transmission in frictional-cohesive material on verge of movement, and correlates with it results of Rankine, Navier, Guest, Bell, and Resal; general equation gives necessary relation between principal stresses, cohesion, and frictional angle. Appendix: Some Simple Experiments on Dry Sand, by C. R. Tranberg.

WATER PIPE LINES

BRIDGES. What Method Is Best in Installing Water Mains on Bridges, S. E. Killam. *Water Works Eng.*, vol. 83, no. 19, Sept. 10, 1930, pp. 1357–1358, 5 figs. Suggestions on methods of boxing and various methods of suspending mains; crossing long span over railroad; pipe bridge girders and I-beams.

CONSTRUCTION. Extension of Pipe Line through Swamp Presents Many Problems, S. H. Taylor. *Water Works Eng.*, vol. 83, no. 19, Sept. 10, 1930, pp. 1351–1352, 1392 and 1393, 3 figs. Report on laying of 48-in., cast-iron pipe line, 6,600 ft. long, through cedar swamp, for water supply of New Bedford, Mass.; line laid upon pipe bents; men worked in boats in trench, and from plank platforms; transportation of material; cost.

RIVETED STEEL. Building a Steel Water Supply Conduit under Usual Conditions, S. M. Van Loan. *Water Works Eng.*, vol. 83, no. 19, Sept. 10, 1930, pp. 1356 and 1403–1404, 5 figs. Report on construction of 20,000 ft. of 93-in. × $^{9}/_{16}$-in. riveted-steel pipe, from Torresdale filter plant to pumping units of Torresdale Station, Philadelphia Water Supply; types of construction; specification for pipe; construction of piers in marshland.

WATER PUMPING PLANTS

STEAM TURBINES. The Steam Turbines as Applied to Borehole Pumping, J. F. Haseldine. *Water and Water Eng.* (*Lond.*), vol. 32, no. 380, Aug. 20, 1930, pp. 366–371 and (discussion) 371–373, 5 figs. Description of Roestock pumping station of Barnet District Gas and Water Co., equipped with steam turbine of vertical impulse type, 275 b.hp. and 7,700 r.p.m., driving four-stage turbine centrifugal pump.

WATER TREATMENT

HYDROGEN ION CONCENTRATION. Manipulation of pH in Water Purification, C. H. Spaulding. *Water Works and Sewerage*, vol. 77, no. 8, Aug. 1930, pp. 283–284, 1 fig. Report on experiences at filtration plant of Department of Water, Light, and Power, of City of Springfield, Ill.; method of feeding lime; recarbonation; effects of pH values. Abstract of paper presented before Am. Water Works Assn.

TASTE AND ODOR REMOVAL. The Taste Problem Solved, J. R. Baylis. *Water Works and Sewerage*, vol. 77, no. 9, Sept. 1930, pp. 299–305. Description of progress in taste removal from water supply; declorination with sulphur dioxide and with sodium bisulphite; chlorine-activated carbon treatment; adsorption by activated carbon; ammonia-chlorine treatment; comparison of phenol adsorption with lignite before and after activation; potassium permanganate treatment; future of taste elimination; comparison of taste elimination processes. Bibliography.

WATER WORKS ENGINEERING

BOSTON. Constructing a 14-Mile Tunnel for Boston's New Water Supply. *Eng. News-Rec.*, vol. 105, no. 11, Sept. 11, 1930, pp. 420–424, 9 figs. Report on driving of Wachusett-Coldbrook tunnel; work carried on through seven shafts by variety of drilling and mucking methods; present development taps Ware River, while future 11-mile extension will reach to Swift River, giving city 191 m.g.d. additional supply; drilling and shooting diagram for full-face heading system and for heading and bench system; layout of portable underground concrete-lining plant; cross section of pneumatic concrete gun.

HOLLAND. Water Supply Problems in Holland, F. A. Liefrinck. *Pub. Works*, vol. 61, no. 9, Sept. 1930, pp. 19–20, 65–66, and 69, 8 figs. Dutch government engineer states that 61 per cent of population used public water supplies, obtained from dunes, underground sources, and rivers, about one-fourth of the systems being privately owned; government advises communities and subsidizes undertakings; geo-hydrological conditions described; maps showing towns and districts in possession of central water supplies; equilibrium of ground water in sandy island and in dunes; architecture of water towers.

SOUTH AFRICA. Rand Water Board Activities, C. F. Mason. *Surveyor* (*Lond.*), vol. 78, no. 2012, Aug. 15, 1930, pp. 159–161, 2 figs. Description of open weir, 1,400 ft. long, built across Vaal river, 25 mi. downstream from Vereeniging; barrage consisting of 35 piers and 36 openings; filter house; boiler house; engine house and plant. Paper presented before S. African District of Instn. of Mun. and County Engrs.

STORAGE RESERVOIRS. Stored Water, How to Get, Preserve, and Improve It, E. B. Whitman. *Eng. News-Rec.*, vol. 105, no. 11, Sept. 11, 1930, pp. 416–419, 4 figs. Article discusses storage problem and necessary correlation between storage and aqueducts and treatment; among factors involved are reservoir location, hydrology of stream, topography of watershed, dam, structures needing relocation, sanitary precautions and silting; purification by storage.

general
n prin-
angle.
n Dry

stalling
Water
30, pp.
nods of
mains;
bridge

hrough
Taylor.
), 1930,
Report
,600 ft.
pply of
bents;
plank
st.

Water
ditions,
83, no.
1404, 5
ft. of
Torres-
resdale
ypes of
nstruc-

ines as
seldine.
no. 380,
n) 371-
umping
er Co.,
impulse
g four-

nipula-
aulding.
8, Aug.
eriences
Water,
ld, Ill.;
effects
d before

e Prob-
rks and
99-305.
al from
hur di-
ne-acti-
y acti-
atment;
lignite
perman-
ination;
Bibli-

nnel for
ws-Rec.,
20-424,
tt-Cold-
h seven
g meth-
r, while
t River,
drilling
system
yout of
plant;

in Hol-
61, no.
, 8 figs.
61 per
upplies,
ces, and
s being
mmuni-
ydrolog-
g towns
ter sup-
y island
ers.

tivities,
78, no.
s. De-
t across
eniging;
penings;
use and
an Dis-
s.

r, How
hitman.
1, 1930,
storage
een stor-
ong fac-
ology of
, struc-
cautions